SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1903.

GENERAL PHYSICS.

950. *Metrical System of Weights and Measures.* **A. Siemens.** (Inst. Elect. Engin., Journ. 32. pp. 278–284; Discussion, pp. 284–326, March, 1903.)—The author recommends the metrical system, drawing especial attention to the fact that its adoption caused little trouble in other countries, and to the British legislation on the subject. In the discussion **F. Bramwell** opposed the metrical system as well as any decimal system, dwelling upon the confusion which the omission of the decimal point had caused, and to the objections raised by Napoleon I. and by practical men. **J. E. Dowson** spoke for the metrical system; **T. Parker** for his own; **Johnstone Stoney** for a slight alteration in the standards; **Andrew Noble, Kelvin, W. Preece, J. N. Shoolbred, A. E. Levin, R. H. Smith,** and **A. Campbell** for the metrical system; **L. S. Robertson, B. H. Brough, J. Wolfe Barry, Tannett Walker, C. E. Webber,** and **R. E B. Crompton** against it, preferring a duodecimal system, and fearing the losses which the change would involve, and further, on account of the screw gauge, &c. **A. Siemens,** in his reply, particularly met this last objection. H. B.

951. *Viscosity of Liquids determined by Capillary Waves.* **F. R. Watson.** (Phys. Rev. 15. pp. 20–38, July, 1902.)—In this paper the author describes the results of experiments on the ripple waves of a liquid surface. They were observed to decrease in amplitude as they progressed from the origin, apparently because of viscosity. It was inferred that the viscous force might be determined in terms of measurable quantities. The paper gives first the mathematical theory. Starting from the usual velocity potential ϕ, which satisfies $d^2\phi/dx^2 + d^2\phi/dy^2 + d^2\phi/dz^2 = 0$, the author arrives at the equation—

$$\frac{d^2s}{dr^2} + \frac{1}{r}\frac{ds}{dr} + k^2s = 0,$$

in which s is a function of r, the distance from the centre of the waves, and k a constant. Of this a solution is obtained by means of Bessel's functions, $s = AJ_0(kr) + BY_0(kr)$, in which the second term is introduced for symmetry only. The dissipation has to be calculated over a small area of the surface, from r to $r + \lambda$, and this equated to the time rate of decay of the energy over the same area. If δ denote the density of the liquid, 2ρ the radius of curvature of the wave crest, $2\rho_n$ the radius of curvature for the nth wave, μ the coefficient of viscosity, T the period of the waves, he finally obtains the equation—

$$\frac{\mu}{\delta} = \log_{10}\left(\frac{\rho_n}{\rho_0}\sqrt{\frac{r_0}{r_n}}\right)\frac{1}{2k^2nT \times 0{\cdot}43429}$$

He next obtains by a continuation of the same method formulæ for surface tension. It is found that in this relation the same formula applies to the diverging circular waves and to plane parallel waves [see Abstract No. 1613 (1901)]. Then follows a description of the apparatus employed, and of the methods used in measurement, illustrated by a graphical test. The amplitude of the waves for water is found to be unexpectedly small. At a distance of 14 cm. from the vibrator, θ, the amplitude was only 0·00001465 cm. At distance 0·917 cm. $\theta = 0{\cdot}000712$. To these, however, he adheres. The paper concludes with a discussion of the behaviour of different liquids employed in the experiments, viz., water, mercury, and others. For water and mercury it was difficult to avoid surface contamination. S. H. B.

952. *Relations of the Viscosity of Liquids to the Temperature and to Chemical Constitution.* II. **A. Batschinski.** (Soc. Imp. Nat. Moscou, Bull. 3. pp. 265–287, 1902.)—The author brings together the viscosity constants for a large number of compounds in order to test the parameter law, and he finds that for about one-half of these substances the function $\eta(t + 273)^3$ remains constant within a certain interval of temperature. Besides water, bromine and nitrogen peroxide, the following classes of compounds are treated of: Paraffins, unsaturated aliphatic hydrocarbons, chlorides, bromides, iodides, nitro-derivatives, sulphur-compounds, aldehydes and ketones, ethers, anhydrides, acids, alcohols, esters and aromatic compounds. It is found that water, acids, and alcohols do not obey the law, which, however, holds for other compounds from 56° to the boiling-point except for CCl_4, $C_2H_4Br_2$ and its homologues, CS_2, C_6H_6, and certain esters, for which the law does not hold even in the neighbourhood of the boiling-point. Substances which follow the law below the boiling-point mostly do so above that temperature, but this is not the case with CCl_4, C_6H_6, or esters, and probably not with water, alcohols, or acids. At low temperatures the law loses its validity. The author supposes that the exceptions in the case of hydroxyl and other compounds depend upon a change of the association with the temperature. The dependency of the function on the temperature shows mostly a minimum in the interval 0·53 — 0·63 of the reduced temperature, even with substances which obey the law. The author shows that the expression $M^{\frac{1}{2}}\theta^{\frac{7}{6}}/Em^{\frac{2}{3}}$ (M being the molecular mass, θ the critical temperature, m the true volume, A the molecule, and E the viscosity parameter) has the same value for each of the laws of corresponding states and of the liquid under the viscosity parameter, and he also explains some other forms of the expression. The experimental verification of one of these expressions shows that the deviations are smaller than those conditioned by the errors of observation of the data employed. In these deviations there is a certain regularity, for, taking the values for B [$M^{\frac{1}{2}}\theta^{\frac{7}{6}}/E(MR)^{\frac{2}{3}}$, where MR is the molecular refraction], it is found that for substances with small molecular mass and low critical temperatures these are higher than 38·5, whilst when the molecular mass and critical temperature are high the values are less than 38·5. This formula can be made

use of for calculating critical temperatures. For substances which do not obey the parameter law the deviation is, for all compounds except CS_2, in the same direction, η decreasing more rapidly than the cube of the absolute temperature. The internal friction, calculated from the above expression, for substances not following the law is always too high, the exceptions to this rule being CS_2, and water above 4°. [See also Abstract No. 733 (1902).] T. H. P.

953. *Singular Trajectories of the Restricted Problem of Three Bodies.* **T. Levi-Civita.** (Comptes Rendus, 136. pp. 82–84, Jan. 12, 1903.)—The three bodies consist of two bodies of masses, μ, $\nu(=1-\mu)$ at unit distance revolving with uniform angular velocity $\frac{d\omega}{dt}=1$ round their common centre of gravity, and a third body P of negligible mass. If ν is at S, μ at J, and the third body at P, $SP=r$, angle $PSJ=\theta$, $JP=\Delta=\sqrt{1+r^2-2r\cos 0}$. Also $V=1/\Delta-r\cos\theta$, and—

$$F=\frac{1}{2}\left\{R^2+r^2\left(\frac{\Theta}{r^2}-1\right)^2\right\}-\frac{1}{2}r^2-\frac{\nu}{r}-\mu V.$$

The canonical equations of motion are—

$$dr/dt=dF/dR=R,\quad d\theta/dt=dF/d\Theta=\Theta/r^2-1,$$
$$dR/dt=-dF/dr,\quad d\Theta/dt=-dF/d\theta.$$

Since $\Theta/r^2=1=d\theta/dt$, $\Theta=r^2(1+d\theta/dt)=r^2(d\omega/dt+d\theta/dt)$, that is, Θ is twice the area described in unit time by r from a fixed line through S. He refers to a proposition of Painlevé, that the motion is regular except when a collision occurs. A singular trajectory (denoted by Σ) is when limit $r(t=t_1)=0$. Jacobi's integral is $F=-C$, or $R^2=r^2+2\nu/r+2\mu V-r^2(\Theta/r^2-1)^2-2C$. R being so defined, the equations of the singular trajectories become—

$$\text{II.}\quad d\theta/dr=-dR/d\Theta,\quad d\Theta/dr=dR/d\theta.$$

Then he assumes $\rho=\sqrt{r}$

$$\theta'=\Theta/r^2-1=\Theta/\rho^4-1$$
$$W=\sin\theta(1-1/\Delta^3)$$
$$\rho P=\frac{1}{2}\frac{d}{d\rho}[\rho^2(-2C+2\mu V+\rho^4)]$$
$$H=-\rho R=\pm\sqrt{2\nu-\rho^6\theta'^2+\rho^2(-2C+2\mu V+\rho^4)},$$

whence the system of singular trajectories Σ is given by $d\theta/d\rho=-2\rho^3\theta'/H$, $\rho d\theta'/d\rho=-L(1+\theta')-2\mu\rho W/H$. It follows that on each Σ, θ and θ' are holomorphic functions of ρ, so long as ρ is very small and >0. He concludes that (1) the inferior limit of H when $\rho=0$ is ± 0; (2) limit $\theta'(\rho=0)=-1$; limit H $(\rho=0)=\pm\sqrt{2\nu}$. (3) The system Σ admits of ∞' integrals, $\theta(\rho)$, $\theta'(\rho)$, holomorphic in the domain $\rho=0$, and reducing when $\rho=0$, θ to an arbitrary value, and θ' to -1. (4) By a generalisation of a theorem of Briot and Bouquet there are no other integrals satisfying (3), it being understood that ρ tends to zero along the real axis. (5) Since $dt=\frac{dr}{R}=-2\rho^3\frac{d\rho}{H}$, the holomorphic integrals define completely the trajectories Σ. And finally the singular trajectories, along which P and S undergo collision at the end of a finite time, correspond to ∞' integrals of Σ holomorphic for $\rho=0$, and to these alone. S. H. B.

954. *Condition for Collision in the Restricted Problem of the Three Bodies.* **T. Levi-Civita.** (Comptes Rendus, 136. pp. 221–223, Jan. 26, 1903.)—Using the results of his former paper [see preceding Abstract] and the same notation, the author here considers the conditions necessary for a collision. The trajectories must belong to the system Σ of the former paper. The integrals must be of the form (1) $\theta = \theta_0 + \rho\alpha(\rho\theta_0)$, $\theta' = \rho\beta(\rho\theta_0)$, in which α and β denote series of powers of ρ. For a collision it is sufficient and necessary that ρ, θ, θ' satisfy the equation resulting from the elimination of θ_0 from (1), namely—

$$(3) \quad 5f + \rho\frac{df}{d\rho} = -2\mu\frac{\mathrm{W}}{\mathrm{H}} - \frac{2}{\mathrm{H}}\rho^3(1-\rho f)\frac{df}{d\theta}.$$

Assuming $f = \sum_0^\infty f_n\rho^n$, he shows that the coefficients f can be found by successive approximations. An important conclusion is drawn, that f is a periodic function of θ. Theoretically the solution is complete. The further conclusion follows that if at a given instant the condition (2) of the conclusions of the former paper is not satisfied, there can never be a collision. The inequation $\theta' + 1 - \rho f \gtrless 0$ insures this. The question is then raised concerning celestial bodies. In the case of any two of them it is necessary if no collision is to occur that the distance between their centres exceed a certain limit. To make this correspond with the theoretical problem, it is necessary not only that there shall be no collision ($\theta' = -1$), but also that the distances SP, JP, should always exceed a certain limit ϵ. He asks the question whether this is secured by two inequations of the $(\theta' + 1 - \rho f) \gtrless \phi(\epsilon)$ where ϕ is some function, but leaves it unanswered. S. H. B.

955. *Longitudinal Oscillations of Bars formed of Pieces parallel to the Axis of Length.* **O. Waldstein.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 930–934, July, 1902. From the Physical Institute of the University of Vienna.)—Stefan has investigated the oscillations of bars formed of pieces at right angles to the axis of length, obtaining results in agreement with his theory. In this paper are considered bars formed of parallel longitudinal pieces. The writer considers two such bars in which the elasticities are E_1, E_2, the densities ρ_1, ρ_2, and the areas of section q_1, q_2. For each bar singly the frequency of oscillation is given by $n = \frac{1}{l}\sqrt{\frac{E}{\rho}}$, where l denotes the length. For the combination of bars he obtains for the frequency N—

$$N = \frac{1}{2l}\sqrt{\frac{E_1q_1 + E_2q_2}{\rho_1q_1 + \rho_2q_2}}$$

E_1 and E_2 can now be found from the equations $n_1 = \frac{1}{l}\sqrt{\frac{E_1}{\rho_1}}$, $n_2 = \frac{1}{l}\sqrt{\frac{E_2}{\rho_2}}$

Hence $N^2 = \frac{q_1\rho_1n_1^2 + q_2\rho_2n_2^2}{q_1\rho_1 + q_2\rho_2}$ and generally for any number of pieces $N^2 = \frac{\Sigma q\rho n^2}{\Sigma q\rho}$

These values are compared with the results of experiments given in tabular form for different materials. S. H. B.

956. *Application of the Principle of Least Constraint to the Oscillations of an Elastic String.* **H. Brell.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1038–1045, July, 1902.)—In this problem we have a system defined by n generalised co-ordinates $p_1 \ldots p_n$, so that the kinetic energy is $\frac{1}{2}\Sigma_{kl}p_kp_l$. The form in which the Principle of Least Constraint is introduced is as follows: There are n Lagrangian equations corresponding to the n co-ordinates. Let them be $Q_1 = 0 \ldots Q_n = 0$. Then the constraint is defined to be a certain homogeneous quadratic function of $Q_1 \ldots Q_n$, and is denoted by Z. Of course since $Q_1 = 0$, &c., $\delta Z = 0$, and so Z is said to combine in one expression all the Lagrangian equations. The writer then treats the problem of an elastic string with fixed ends, regarding it first as a series of discrete particles between which a force acts resisting displacement, secondly as a continuous string. The solution is obtained in either case by the Lagrangian equations, no method being apparent by which Z can be formed without the Q's being first known. Placing all the Lagrangian equations in one expression Z is very elegant for the analyst, but it is only by a figure of speech that Z can be said to be applied to the solution of the problem. The Lagrangian equations are sufficient without it. It does not exist without them. S. H. B.

957. *Vibrations of Gun-Barrels.* **C. Cranz** and **K. R. Koch.** (Nature, 67. pp. 248–249, Jan. 15, 1903. From the Abhandlungen of the Bavarian Academy, cl. 2, vol. 21, part 3, pp. 559–574.)—It is known that when a cylindrical rod is struck by an approximately axial blow, the particles of the rod perform in general elliptic vibrations, the axes of which vary in direction at different points, and it was one of the objects of the present work to find how far a gun-barrel behaved in the same manner. A number of military Mauser rifles were furnished with projecting wires, and the motions of their shadows, thrown on a screen by a lens, were photographically recorded side by side with a tuning-fork trace. It was thus found that the vibrations are in general of an elliptic character, and consist of a fundamental and overtones. The periods of vibration of the prime and first two overtones are of the order 0·04, 0·008 and 0·002 of a second. It was arranged that the instant of the bullet leaving the muzzle should be shown by a white dot on the photograph. The diagrams given show that in one case (that for a 6-mm. Mauser rifle) the bullet is clear of the barrel before any deflection due to vibration has occurred. This is obviously an important practical result. E. H. B.

958. *Equilibrium of Rotating Liquid Cylinders.* **J. H. Jeans.** (Roy. Soc., Phil. Trans. 200. pp. 67–104, Nov. 25, 1902. Roy. Soc., Proc. 70. pp. 46–48, May 12, 1902 (Abstract).)—The author points out that the chief difficulty in the problem of determining the equilibrium configurations of a rotating liquid consists in determining the potential of a mass of homogeneous matter of which the boundary is given. The method which he employs to obtain this potential is to regard the potential function as the solution of a differential equation subject to certain boundary conditions. The potential can then (theoretically) be obtained by transformations of the function determining the boundary. In three-dimensional problems the method is not a practicable one, as it depends upon a continued application of the formula expressing the products or powers of spherical harmonics as the sum of a series of harmonics. In two dimensions, however, the spherical harmonics may be replaced by circular functions of a single variable, making the transformation manageable. The author therefore confines his attention to two-dimensional problems. The linear series of circles and ellipses, corresponding to the Maclaurin spheroids and Jacobian ellipsoids, are investigated, and the points of bifurcation found. The first of these points on the second series leads to a pear-shaped curve similar to that of Poincaré; and an exchange of stabilities is shown to take place at this point. The linear series which starts with this pear-shaped figure is then investigated, the equation being expanded in ascending powers of a parameter θ, the calculation being extended only as far as θ^5.

G. W. DE T.

959. *Stability of Equilibrium of a Pear-shaped Rotating Liquid.* **G. H. Darwin.** (Roy Soc., Phil. Trans. 198. pp. 301–331, March, 1902, and 200. pp. 251–314, Jan., 1903. Roy. Soc., Proc. 71. pp. 178–183, Jan., 1903 (Abstract).)—The substance of the analysis in these papers is essentially the same as that of Poincaré's paper on the same subject [see Abstract No. 1662 (1902)]. The arrangement and notation, however, are entirely different, the author employing the methods developed in his paper on Ellipsoidal Harmonic Analysis (Roy. Soc., Phil. Trans. 197. pp. 461–557). Poincaré, in the paper referred to above, has shown how the problem of the stability of the pear-shaped figure may be definitely solved, but he has not pursued the arduous task of converting his analytical results into numbers, and has therefore left the question of the stability of the pear still unanswered. The author considers that the approximation arrived at in his second paper may be regarded as proving, "but by something short of an absolute algebraic argument," that the pear-shaped figure is stable. The numbers obtained in the course of the determination of the stability afford the means of giving a second approximation to the form of the pear. He observes that it is hardly too much to say that in a well-developed pear the Jacobean ellipsoid has nearly regained its primitive figure, but that it has shot forth a protuberance at each end. A consideration of the figures, with a conjectural extension of them, and their comparison with those obtained by Jeans [see preceding Abstract], almost reminds one of some such phenomenon as the protrusion of a filament of protoplasm from a mass of living matter. In spite of Poincaré's warning as to the danger of applying these results to heterogeneous masses, and hence to cosmogony, he observes that he cannot restrain himself from joining him in seeing in this almost life-like process a counterpart to at least one form of the birth of double stars, planets, and satellites. G. W. DE T.

960. *Wind-Pressure Recorder.* **W. Kouznetzow.** (Acad. Sci. St. Pétersbourg, Bull. 17. pp. 81–89, June, 1902.)—The principle underlying the construction of this apparatus is as follows: Let a wind motor with vertical axle be given, bearing on the latter a disc connected with a spring dynamometer. The stronger the wind, the greater will be the pressure to which the motor is subjected; the magnitude of this pressure may be judged from the readings of the dynamometer, being proportional to the strength of the wind, in the case of the motor being so constructed that the wind for varying directions exerts its pressure equally on the motor. A. G.

961. *Gravitation in France.* **J. Collet.** (Comptes Rendus, 135. pp. 956–959, Dec. 1, 1902.)—In continuation of his first paper [see Abstract No. 619 (1903)], the author gives the values of g for twelve stations on or near the 45° lat., comprising Paris, Marseilles, and Turin. Reductions to sea-levels are made after Bouguer's formula, taking 5·5 as density of the earth, and values varying between 1·9 and 2·73 as densities of the ground underneath the stations. In all but two cases gravity is proved to be below the normal value, the more so the higher the mountains rise (up to 4,100 m.), showing that the average density of the earth is less under the mountains than under the plains and the sea. H. B.

962. *Possibility of Preventing Damage by Frost.* **P. Olsson-Seffer.** (Roy. Soc. Queensland, Proc. 17. Part 2. pp. 101–122, 1903.)—The author discusses the causes of night frosts—for the study of which Queensland, situated on the edge of the Tropics, would be particularly suitable—their effects upon plants, and their prevention by the production of smoke (Lemström's frost torches), and other means, on general lines, relying chiefly on the work done in Finland and Sweden by Lemström and Homén, and by others in Germany. A list of literature comprising 95 entries is added. H. B.

963. *Recording Instruments for Earthquakes.* **G. Lippmann.** (Comptes Rendus, 136. pp. 203–204, Jan. 26, 1903.)—As the drums of continuous seismographs are too small, and as large drums cannot run continuously and must be released, the author proposes to connect several recording stations with one warning station by telegraph wires. The earthquake closes the circuit of the line battery at the warning station; the current starts the instruments at the other stations, and can also be utilised for determining the velocity of the propagation of the earthquake. H. B.

964. *Earthquake at Smyrna.* **Yung.** (Comptes Rendus, 136. pp. 66–68, Jan. 5, 1903.)—An earthquake occurred at Smyrna about 11 p.m. on Nov. 23, 1902, and was followed by minor shocks on Nov. 24, and almost daily shocks in the interval Dec. 4 to 15. Some of these were only recorded by the instruments, a Cancani seismometrograph, a Galli seismograph, and horizontal pendulums. H. B.

965. *The Dust-Fall of March* 9 *to* 12, 1901. **J. Valentin.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 727–776, May and June, 1902.)—The author deals with the subject from the meteorological standpoint. Having given a list of dust-storms, mostly of the nineteenth century, but beginning with 1646, he traces the dust-fall to a sand-storm which was reported from Northern Algeria on the night of March 7 and 8, and which he follows through Italy, Austria-Hungary, and Germany. Most of the dust fell south of the Alps, none in southern Germany; Bohemia, Moravia, and Silesia had not even rains; in northern Germany the fall was sporadic. With the aid of isobars, which he computes for the levels of 400 m. and 2,500 m., the author wishes to establish that the dust was carried by a cyclone which crossed the Alps accompanied by thunderstorms. The cyclone advanced with a speed of about 50 km. per hour, first in a northerly, then in a north-easterly direction. The wind blew at a rate of 80 km. and more, and the air completed a revolution in 100 hours. There was no broad air-current conveying the dust, such as Hellmann and Meinardus, and also Róna assumed, but the dust was deposited from the same masses of air when in different quadrants. The centre of the chief depression was over Finland all the time. The partial disturbance must have broken through a wedge or saddle of high pressure which moved from the south-eastern extremity of the Alps over Lombardy and caused a bora in the Adriatic and a foehn in the Eastern Alps. Most dust-falls are cyclonic in character. H. B.

966. *Cyclones and Anti-Cyclones.* **F. H. Bigelow.** (Monthly Weather Rev. 31. pp. 26–29, Jan., and pp. 72–84, Feb., 1903.)—The barometric pressures on the sea-level and the 3,500-ft. and 10,000-ft. levels having daily been reduced for 175 stations in the United States and Canada since December 1, 1902, as described in Abstract No. 776 (1903), the author now

publishes in the first article the isobars, for these three levels, of two cyclones of January 2 and 7, 1903, and in the second article similar curves for three more cyclones of February 7, 8, and 27. The results confirm the author's views. The closed isobars at sea-level tend to diminish in number and intensity at higher levels, and finally open out into shallow inflected curves. These latter curves in opening out first form cusp-shaped curves, joined by a saddle of pressure higher than that north and south of them ; the high pressures to the east and west of the cyclone diminish in area and fade away with the long, looping isobars of the upper strata. The author considers that the daily stream lines of the upper planes, deduced by computation from surface data, are as reliable as those which could be obtained from a series of local cloud observations. He gives diagrams explaining the formation of local cyclones and anti-cyclones with their general circulation about the North Pole; further comparative diagrams of the vectors of motion of cyclones and anti-cyclones on the 1,000-m. and 3,000-m. levels and on his levels; reproduces charts from the International Cloud Report to show the stream lines in cyclones and in the cirrus levels of hurricanes, and thus arrives at a scheme for the distribution of the eastward drift by the penetration of a cyclone vortex into the upper strata. He concludes that the cyclone is not formed from the energy of the latent heat of condensation, however much this may strengthen its intensity, and that the German vortex theory (local heat centre, zero velocity at centre) is nearer the truth than the Ferrel vortex. The direction of the advance of the low-pressure centre is controlled by the upper strata, so that the track and the velocity of the daily motion are indicated by the 10,000-ft. level isobars. Precipitations seem to occur over areas where the 3,500-ft. and the 10,000-ft. level isobars cross each other.

H. B.

967. *Meteorological Observations at Moscow during* 1901. **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 3, pp. 288–318, 1902.)—The observations [see Abstract No. 645 (1902)] have been continued in the University Observatory, 156 m. above sea-level, by Pitschuschkin, Speranskij, and Pokrowskij. The extreme diurnal range of the barometer was 25·4 mm. (in February), the extreme temperature variation of 25·3° was observed in April. There were 157 days without frost, and 112 days on which the thermometer did not rise above 0°. At the depth of 0·2 m., there was no frost on 268, at 0·4 m. depth on 348 days; at 0·4 m. the temperature was constant within 0·9° for 3½ months (winter). No frost occurred at depths of more than 0·8 m. At 2·5 m. the extreme temperatures were + 12·8° and + 3°, at 0·2 m. depth + 25·5° and — 2·3°, at 0 m. + 47·9° (June 27) and — 7·9°, on the grass (or snow) + 29·6 and — 27·6, in the air, 3 m. above the ground, + 35·32 (August 7) and — 27·5 (December 26). The summer was exceptionally bright, the winter, which is as a rule brighter than the summer, cloudy; 202 days are counted as cloudy. The further observations concern humidity, wind direction, and strength, atmospheric electricity (one thunderstorm in April, one in June, two in July ; no aurora), optical phenomena, halos, &c., and comparative records of a black bulb thermometer of Fuess, mounted in March, and of the ordinary thermometer.

H. B.

968. *Vertical Components of Cloud Movements.* **L. Besson.** (Monthly Weather Rev. 31. pp. 22–24, Jan., 1903. Translated from the Annuaire Société Météorologique de France, pp. 180–185, 1902.)—It has been observed at Montsouris and confirmed by Teisserenc de Bort at Trappes, that the

apparent direction of cloud movements, as determined with the aid of nephoscopes, varies considerably with the point of the sky observed. This should be so when the clouds move not horizontally, but along an inclined path with a vertical component. The author deduces a formula for this deviation from the real path. His formula becomes very simple when two points are observed whose azimuths are at right angles to the movement of the clouds and whose altitudes are 45°. This is not always possible, of course, as there may be no clouds in the respective portion of the sky. The formula does not answer well for clouds of medium and high elevations, however, and it seems that even the upper air currents above large towns have not a uniform direction. H. B.

969. *Synchronous Changes in the Solar and Terrestrial Atmospheres.* **F. H. Bigelow.** (Monthly Weather Rev. 31. pp. 9–18, Jan., 1903. Paper read before Section A of the A.A.A.S., at the Washington, D.C., Meeting, Dec. 28, 1902.)—Having shown that the sunspots constitute only a sluggish register of the solar activity, and that the terrestrial magnetic force exhibits a set of characteristic minor fluctuations superposed on the general 11-years' curve, the author points out that these special variations reappear distinctly in the solar prominences as measured by their frequency numbers, and also in the mean annual pressure of all the portions of the earth. In these short cycles of three or four years he agrees with Lockyer [see Abstracts Nos. 198 and 291 (1903)]. In the United States the synchronism between solar and terrestrial phenomena holds for pressures, temperatures, storm track movements, and cold waves tracks. The author discusses in detail the movements of the sunspots, prominences, and faculæ in latitude and longitude, taking the observations of Secchi, Tacchini, Ricco, and Fenyi since 1871, and referring to Lockyer. As the sunspots have a longer life than the faculæ and prominences, they are less likely to be altogether obscured, and the terrestrial term can therefore be eliminated to a certain extent. The 11-years' cycle is strongly developed for the prominences in the equatorial zones and nearly disappears near the poles. The irregularity in the series of crests (frequency numbers) found during the same year in different zones is, however, very large, and the sun seems to act like a congested body discharging a viscous mass through a series of distortions on different portions of its mass. The prominences have two distinct maxima as a rule, but the one maximum disappears in high latitudes (60 to 70°) at the time of the maximum sunspot frequency, and the one in low latitudes disappears at sunspot minimum. Spots and faculæ have each only one maximum in the same hemisphere. The diagrams of the movement of the maximum point of relative frequency in latitude during the 11-years' cycle are not the same for the two hemispheres; this concerns prominences, spots, and faculæ. The author assumes that the equatorial angular velocity is that of the nucleus of the sun, and that the poles should have the same velocity, giving a synodic rotation of 26·68 days, while the middle latitudes should have a smaller velocity, giving a synodic rotation of 27·30 days for latitudes 12 to 15°.
H. B.

970. *Curvature of the Air-currents in Atmospheric Whirls.* **B. Sresnewsky.** (Acad. Sci. St. Pétersbourg, Bull. 16. pp. 185–194, April, 1902.)—The author describes a geometrical construction for the centre of curvature of circular cyclones. Determining these centres for the octants of Ley's cyclones, he finds that the centres lie on an ellipse, whose major axis is parallel to the direction in which the cyclone moves, and which is situated to the right of the path, but symmetrical as regards front and back of the cyclone. As we rise to higher altitudes, the ellipse shrinks to a point (about the level of the cumuli which drift along the isobars) and reappears then to the left of the cyclone path. The locus of this ellipse is thus a doubly conical surface. The ellipse is on the right side of the path (as stated), when the cyclone is essentially fed from the front, to the left when fed from the rear. These arguments can be applied to anti-cyclones. H. B.

971. *Unmanned Balloons in Russia.* **A. de Quervain.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 395–398, Nov., 1901.)—With the support of Rykatcheff and Leyst, the author has sent up, in the months January to April, 1901, three balloons from St. Petersburg and twenty-three from Moscow. The balloons were of Teisserenc de Bort's paper type, and were fitted with his registering instruments; most of them were charged with illuminating gas. All the balloons except one were recovered; the records are tabulated in the paper. The maximum altitude reached was 12,310 m. at the minimum temperature of −66·6°. H. B.

972. *Observations during an Aerostat Ascension.* **W. Kouznetzow.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 217–224, Sept., 1901.)—From the observations made during a recent ascension from St. Petersburg, it is seen that at a height of about 500 m. there were warmer air-currents than below, the velocity of the upper currents being less than that of the lower currents, and from a height of about 500 m. the decrease in the velocity of the air became nearly constant. In the neighbourhood of these currents, stratified clouds were observed, as well as a maximum relative moisture and a material increase in the temperature of the air. A. G.

973. *St. Petersburg Temperature Changes.* **D. Smirnov.** (Acad. Sci. St. Pétersbourg, Bull. 17. pp. 65–71, June, 1902.)—From the data recorded by the author, approximate conclusions may be drawn as to the difference in the state of the air-currents exerting their influence successively on the observatories. The increase in the absolute percentage in water vapour from one station to the other may be accounted for by the precipitates formed in the outer strata absorbing the same and mixing it with the hot current. A. G.

974. *Total Eclipse of the Sun, May* 26, 1900. *Observations made at Elche, in Spain.* **M. N. Donitch.** (Acad. Sci. St. Pétersbourg, Bull. 13. pp. 473–488, Dec., 1900.)—A series of observations of the spectra of the corona and chromosphere. On the plate taken of the chromospheric spectrum there were 152 arcs, and the wave-lengths of these are given in a table. From the thickness and length of these arcs, the relative heights of the various elements were calculated and found to be 49, 44, and 27·6 thousand km. for calcium, hydrogen, and helium respectively. In a second photograph of the upper limit of the chromosphere, the H and K lines of calcium, the hydrogen lines and a trace of the helium lines only were found. Similar results were obtained with the spectra of certain prominences. The corona showed chiefly a continuous spectrum with a maximum in the orange and red, the bright lines not being obtained. E. C. C. B.

975. *Total Eclipse of the Sun, May* 17, 18, 1901. **M. N. Donitch.** (Acad. Sci. St. Pétersbourg, Bull, 17. pp. 13–38, June, 1902.)—An account

of the results of observations made of this eclipse at Padang, in Sumatra. The spectrum of the chromosphere was photographed with an objective prism, and 60 lines were measured on the plates, of which the wave-lengths are given in the paper; amongst these are to be found Lockyer's two coronal lines at $\lambda = 5301 \cdot 7$ and $\lambda = 4231 \cdot 3$. Similar results are obtained as regards the relative heights of the substances in the chromosphere as in the eclipse of May, 1900 [see preceding Abstract]. Certain remarks are appended on the spectra of the prominences and corona, and on the shape of the latter. E. C. C. B.

976. *The Rôle of Jupiter in the Formation of Compound Radiants.* **T. Brédikhine.** (Akad. Sci. St. Pétersbourg, Bull. 16. pp. 53–95, March, 1902.)—In every apparently stationary radiant, Denning imagines an individual meteor stream, which forms a single family of meteors and, according to the theory of their cometary origin, belongs to a single comet. It is easy, however, to forget the enormous difference between the real and apparent direction of a stream. On the cometary hypothesis, the meteors of one compound stream naturally form a family of small comets produced by the disintegrating action of some large planet, *e.g.*, Jupiter. The author deals at length with the various radiants given by Denning, and sums up the results of his calculations as follows:—In almost every case the origin of the meteors lies in emissions from cometary nuclei; the bodies, emitted after the passage of the comet to its perihelion, must describe elliptical orbits. The bundle of derived orbits will be more likely than the original comet to approach the heavy planets and thus undergo considerable perturbations. These perturbations will be very different for different parts of the same system, and there may arise in this way a series of very varied orbits. In the compound radiants similar series of orbits are to be met with, connected together by their process of evolution. As these emissions take place along a considerable portion of the comet's orbit, there are produced a system of bundles of orbits, so that the phenomena are very complex.

The emissions, further, do not depend in any way upon the direction of travel of the comet. It is possible for the masses detached from the original comet to be sufficiently large to form new comets, including those with elliptical orbits. Several examples have been known of the disintegration of comets which have crossed Jupiter's sphere of action, and we can conceive of such disintegrations arising from internal forces produced by the energy of the sun very far from Jupiter. The probability that a comet of parabolic orbit will meet Jupiter is very small, so that the disintegration due to the internal forces can very likely be, more generally, the origin of the formation of comets with short periods. The sense of the motion is not a characteristic of the meteors, while the periodic comets supposed to be captured by Jupiter always travel in the direct sense. Thus, in the derived elliptical orbits, the size of the greater axes depends on the intensity of the impulse, *i.e.*, the initial velocity, and as a given impulse must project a single meteor with a greater velocity than it does a large portion of the original comet, it follows that generally the elliptical orbits of the meteors must be less elongated than those of the derived comets. In the case of these comets the direction of motion is not characteristic. Jupiter then begins to capture these derived comets, transforming their trajectories into short-period orbits with motion in the direct sense. In certain exceptional cases the original emissions may have been great enough of themselves to form a comet with elliptic orbit and short period; the comet Encke may perhaps be an example of this. In conclusion, the author remarks that the radiant points, when catalogued, should be given with their real, not their relative directions. The coordinates should be referred to the elliptic. E. C. C. B.

977. *Comet*, 1899. I. (*Swift*). **T. Brédikhine.** (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 483–502, May, 1901.)—The author considers all the observations made upon this comet and, from drawings and photographs, draws the following conclusions :—The comet presents a very instructive case of the splitting of one comet into two or more comets with different orbits, and that this process was not due to the attraction of the planets or the sun, but to internal forces developed by the energy of the central star. [See also preceding Abstract.] E. C. C. B.

978. *The Spectroscopic Binary o Persei.* **H. C. Vogel.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 53. pp. 1113–1121, Dec. 18, 1902.)—A series of photographs taken of the spectrum of this star show clearly that it has very variable velocity. Unfortunately the lines were thick and ill-defined, so that measurements were not very accurate. The velocities, however, lie very well upon a curve which shows the period to be 4·39 days and a maximum velocity of ± 105 km. The author concludes that the spectrum is in reality formed by the superposition of two spectra, one belonging to one component of type Ib, and the other belonging to the other of type Ia_2. This was confirmed by an examination of the very broad and hazy line Hγ, it being then found that the region of maximum brightness in the line shifted from side to side according as the binary had a positive or negative velocity. E. C. C. B.

979. *Spectroscopic Observations of Nova Persei.* **A. Bélopolsky.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 473–498, Dec., 1901.)—By the use of the figures and formulæ recorded in this paper, the author obtains a table for the wave-lengths of the bands observed on the star by means of spectroscopes. All these bands, no doubt, will occur in the spectra of gaseous nebulæ so far investigated. It, however, should be noted that they also occur in the second spectrum of hydrogen, and that the lines of the ordinary hydrogen spectrum are to be found in the spectra of gaseous nebulæ and, finally, in the spectra of bolides and of lightning. The author thinks it possible that during the visibility of Nova Persei the conditions of radiation of one and the same body (hydrogen) were so considerably changed that the character of the spectrum was also changed, one of the phases becoming identical with the conditions under which the same body radiates in gaseous nebulæ. A. G.

980. *The Brightness of Nova Persei.* **A. Bélopolsky.** (Acad. Sci. St. Pétersbourg, Bull. 16. pp. 31–36, Jan., 1902.)—A series of observations made of the brightness of this star with the naked eye, with opera-glasses, and with the 30-in. refractor and the photographic telescope at Pulkowa. Photographs were also made of the star with the surrounding stars of Perseus with a small Steinheil camera. The measurements of brightness were all relative to other stars of known magnitude and were made between February 25 and August 21, 1901. Equations are given expressing the intensity at various epochs.
E. C. C. B.

981. *Comet*, 1901. I. **T. Brédikhine.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 451–469, Dec., 1901.)—The author has collected together all the observations which have been made on this comet and, from these and from

measurements made on a series of photographs, concludes that there must have been a series of explosions produced by internal forces in the nucleus. The calculations leading to this conclusion are given at length in the paper.
E. C. C. B.

982. *Stability of a Spherical Nebula.* **J. H. Jeans.** (Roy. Soc., Phil. Trans. 199. pp. 1–53, July 31, 1902. Roy. Soc., Proc. 68. pp. 454–455, Sept. 12, 1901 (Abstract).)—This is a mathematical paper in which the author shows that the behaviour of a gaseous nebula differs from that of an incompressible fluid both as regards the amount of rotation required to produce instability and the disposition of the orbits of the planets which will be formed out of the primitive nebula. The fact that the configurations of existing systems are not such as could have originated out of a rotating mass of liquid need not therefore prevent a nebular or meteoritic origin being ascribed to them.
G. W. de T.

REFERENCES.

983. *Agitation of a Liquid in a Closed Receiver.* **G. Guglielmo.** (Accad. Lincei, Atti, 11. pp. 298–305, Dec. 7, 1902.)—The author recommends that the inner wall of the vessel containing the liquid to be agitated should be grooved or provided with suitable projecting plates ; effective agitation can then be secured by rotating the whole receiver. The method is applicable in calorimetric experiments. D. H. J.

984. *Vortex Rings.* **G. Suschnig.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 830–845, May and June, 1902.)—The author describes long-distance experiments with vortex rings, worked by gunpowder and its smoke, and received upon gauze screens covered with coloured soap solution, and also upon snow and other obstacles. Numerous photographs are given. A. D.

985. *Period and Damping of Asymmetrical Vibrations.* **F. A. Schulze.** (Ann. d. Physik, 9. 5. pp. 1111–1123, Dec., 1902.)—Following the work of F. Richarz and P. Schulze [see Abstract No. 826 (1902)] the present author determines for asymmetrical vibrations (1) the period, (2) its division into the times of description of the two unequal amplitudes right and left of the zero position, and (3) the damping. Each part of the theory was experimentally tested by comparison with a magnet set out of the meridian by the torsion of its unifilar suspension. The agreement was very satisfactory. E. H. B.

986. *Theodolite Surveying.* **A. Sporeni.** (Zeitschr. Instrumentenk. 22. pp. 374–376, Dec., 1902. From the Rivista di Topogr. e. Catasto, 14. p. 33, 1901–2.)—The author puts the fundamental equations of lath surveying into new forms and applies them to the ordinary "tachymeter"-telescope. G. E. A.

987. *The Metric System.* **F. A. Halsey.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0956. pp. 1–48, 1902.)—In this paper the author advances arguments against the official introduction of the Metric System. G. W. de T.

988. *The Problem of Weights and Measures.* **S. A. Reeve.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0959. pp. 1–16, 1902.)—In this paper the author advocates the use of a duodecimal system which he sets forth. G. W. de T.

989. *Free Hydrogen in the Atmosphere.* **A. Leduc.** (Comptes Rendus, 135. pp. 1332–1333, Dec. 29, 1902.)—This is a reply to A. Gautier's criticisms [see Abstract No. 872 (1903)] concerning the meaning of density of atmospheric nitrogen. H. B.

990. *Graphical Solution of Deflection Problems.* **W. Trinks.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0961. pp. 1–21, 1902.)—Starting with the ordinary differential equation of bending moment, the author gives simple graphical solutions applicable to various cases met with in practice. G. W. DE T.

991. *Wire-testing Apparatus.* **A. Falkenau.** (Eng. Club Phil., Proc. 20. pp. 132–135, Jan., 1903.)—The author describes a machine by which a specimen of wire may be tested in tension, or may have a definite load, say ½ of the ultimate strength, applied in tension and, while under this load, be bent backwards and forwards across hardened steel blocks of suitable radius. The number of bendings which the wire will undergo before failing is an important indication of its suitability for use in wire ropes; the test by torsion is considered unnecessary and of little value. H. R. C.

992. *Theory of the Planimeter.* **W. J. Tennant.** (Engineer, 95. pp. 75–76, Jan. 16, 1903. Abstract of paper read before the Institution of Junior Engineers.)—In this paper the author gives a simple non-mathematical exposition of the theory of the planimeter, and its use for the determination of areas. G. W. DE T.

993. *The National Physical Laboratory in* 1901. (Report of the National Physical Laboratory for 1901, pp. 3–54, 1902.)—Bushey House was not occupied till September, 1901, and the work, as summed up by the director, R. T. Glazebrook, was carried out in the Kew Observatory. The work comprised gravity and magnetographic observations (by E. G. Constable and J. A. Harker) in connection with the National Antarctic Expedition, earth current observations (Harker), gas thermometer investigations (Harker), and a study of the bending of magnetometer deflection bars (C. Chree and F. E. Smith). The report of the Observatory Department (C. Chree) contains magnetic, meteorological, and seismological observations, verification of instruments, rating of watches and chronometers, and experimental and miscellaneous work; details of the magnetic observations conducted at Falmouth by E. Kitto are also published. H. B.

994. *The National Physical Laboratory in* 1902. (Report of the National Physical Laboratory for 1902, pp. 3–51, 1903.)—Like the previous report, the paper gives an outline of the work done and the work approved of by the executive committee for the following year. The report of the director, R. T. Glazebrook, describes the equipments of the different divisions and the installation and adjustment of the apparatus. The report of the Observatory Department does not comprise the magnetic observations from Falmouth. The staff of the laboratory consisted of forty-five persons, counting caretakers and gardener. H. B.

995. *The Mont Pelée Eruptions.* **A. Lacroix.** (Comptes Rendus, 136. pp. 216–218, Jan. 26, 1903.)—Further particulars on cloud discharges [see Abstracts Nos. 702, 705, and 871 (1903)]. H. B.

996. *Meteorology at Turin.* **E. Ferrero.** (Accad. Sci. Torino, Atti, pp. 3–53, 1902–3.)—A complete series of tables giving the results of the meteorological observations made at the University of Turin during 1902. D. H. J.

997. *Eruption of La Soufrière.* **T. Anderson** and **J. S. Flett.** (Roy. Soc., Proc. 70. pp. 423–445, Aug. 22, 1902.)—This is a preliminary report presented by the authors, who were commissioned by the Royal Society to investigate the recent volcanic eruptions in the West Indies. Descriptions of the eruption obtained from eye-witnesses are given. The authors, after leaving St. Vincent, paid a visit to Martinique, where they arrived in time to witness one of the more important eruptions of Mont Pelée. Illustrations showing the physical conformation of Mont Pelée and the mountain in eruption, accompany the paper. G. W. DE T.

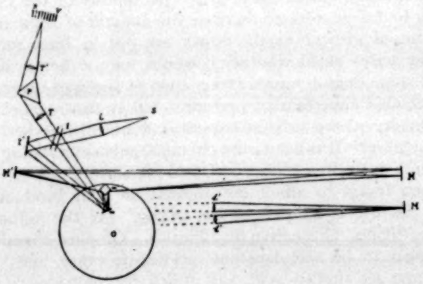
LIGHT.

998. *Machine for Ruling Concave Gratings.* **W. Rollins.** (Amer. Journ. Sci. 15. pp. 49–53, Jan., 1903.)—A machine is described which obviates the defects caused by ruling a curved grating with a machine designed to rule flat surfaces. The carriage holding the blank moves on curved ways of such a size that the blank moves under the diamond in an arc, the radius of which is the same as that of the grating. Several drawings of the machine are given.
G. E. A.

999. *Standard Lamps for Photometric Purposes.* **F. v. Hefner-Alteneck.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 41. pp. 980–992, Oct. 23, 1902.)—The author has made various attempts to improve the Hefner standard lamp, originally introduced by him in 1884. In the actual construction of the lamp, little change has been made, though the thickness of the walls of the wick tube has been increased from 0·1 to 0·15 mm. This has made the lamp burn rather more steadily, besides adding to the solidity of the construction. It has not been found possible to increase the amount of light produced, partly because lamps of greater candle-power are apt to burn rather unsteadily. The question arises as to whether it would not be better to construct the wick-tube of some definite metal rather than of German silver, which is liable to be of somewhat uncertain composition, but in this respect no change has so far been made. As to amyl-acetate, it is doubtful whether this is the best liquid for the lamp. It is not a pure chemical substance, being prepared from fusel oil, which is itself a mixture of two isomeric alcohols. This has not, however, been found to affect the amount of light produced. The chief objection to its use is its penetrating odour. At the author's suggestion, L. Knorr investigated alternative possibilities. Of pure chemical substances, the best appear to be acetylacetone, acetacetic ether, and isobutylacetate. The two former are slightly acid, and attack the metal parts of an ordinary Hefner lamp; but the last has the advantage of being cheap. With regard to mixtures, the main point is to ascertain whether the two components of the mixture tend to burn away at equal rates, *i.e.*, whether the composition of the mixture always remains the same. Various mixtures of benzole and alcohol were taken, containing from 10 to 50 per cent. of benzole. It was ascertained that in such a mixture the alcohol and benzole burn away at the same rates by taking samples at intervals, mixing with water, and measuring the amount of benzole that separated out. This mixture gives a more yellow light than amyl-acetate. If the mixture contains more than one part of benzole to four parts of alcohol, the flame becomes sooty; with one part of benzole to seven of alcohol, the colour of the flame is similar to that of amyl-acetate, but not so bright—moreover, the light is not so steady. It therefore has few advantages. The advisability of using isobutylacetate was considered in 1884; it gives almost exactly the same light as amyl-acetate, but the latter was preferred, as it is more easily obtained and cheaper. An acetylene lamp is a further possibility, and might prove useful in the measurement of white lights, but its details would require much experimental work. The paper concludes with some notes on the construction of photometers. W. H. S.

1000. *Group Velocity and Wave Velocity of Light.* **D. B. Brace.** (Science, 16. pp. 81–94, July 18, 1902. Presidential Address read before the A.A.A.S.

at Pittsburg, June 28 and July 3, 1902.)—The author observes that only in vacuo is it likely that the mean velocity of propagation of a group of periodic disturbances will be identical with that of the individual elements. This has not yet been tested by physical methods. In the case of ponderable media, the author considers that such experiments should provide important data. He points out that the electrical methods of measurement all give the wave velocity, while the optical methods hitherto employed determine a velocity dependent on that of the group. The meanings of the results obtained by Fizeau's and Foucault's methods are discussed, and several methods of determining the group velocity are suggested. The author then describes an apparatus with which he is now experimenting at the University of Nebraska, by means of which he expects to be able to determine, with a high degree of accuracy, and for any colour, the wave velocities in different media, as well as in vacuo. The arrangement is shown in the accompanying illustration. Light from the slit S is converged by a lens L, to a half-silvered plate I, one beam being reflected and the other passing through and being reflected by the mirror I′. Both converging beams strike the mirror *m* at the same point, and are then reflected, the first beam to the adjacent face of the rectangular mirror *m*′, and the second to the opposite face, where they form images of the slit S. The first beam is reflected to M′, then to M, and finally to a focus on *m*′, while the second ray passes over the path of the first to a focus on *m*′. Thence the two rays trace each other's paths, and are reflected and transmitted respectively by the plate I through the spectral system P to the eye, where interference bands are formed. Thus, aside from other losses by reflection, one-fourth of the light reaches the eye. The distant mirror M may be concave, and of the proper focus for the system; or two lenses, I and I′, may be used so as to obtain a greater aperture to the beam. These two rays will in general travel over slightly different paths, and hence give bands which may be conveniently analysed by means of channeled spectra. If now the disc rotates, the path of one of the rays will become greater than the other, and the interference bands will shift. If a spectrum is used, the bands will move across the field, increasing or decreasing in number. If the adjustment is initially made so that the paths are the same, no bands will appear until the disc is set in motion. By counting the number passing any point, we can obtain the order of the interference for that wave-length, and from the dimensions and speed of the disc, determine the wave velocity for that colour. From the position of the other bands at this instant we can calculate the velocity of that colour. Thus we have the means at hand for obtaining the wave velocity for all colours, from which the group velocity for



the same can at once be obtained. The radius to the disc m' is 15 cm., and a speed of 500 per second is assured. The concave mirror M has an aperture of 15 cm. and a radius of curvature of 15 m. This is the arrangement now being used. With this velocity, assuming a band can be read to one-thirtieth part, a distance of only 8 cm. would show a velocity. The rays during transit may be made to pass within a tube which can be evacuated, connecting M and M′. Another arrangement may be used when M is placed at a much greater distance, and is shown in the annexed diagram. I and I′ are two lenses whose foci are M, and their conjugate foci on each face of M′ respectively. G. W. DE T.

1001. *Light Absorption in Symmetrical Crystals.* **J. Boussinesq.** (Comptes Rendus, 136. pp. 193–199, Jan. 26, 1903.)—The resistance of a ponderable molecule to the vibrations of ether is analogous to that offered by an immersed solid to a fluid executing short oscillations about it. If the period of the fluid oscillations be short enough, the resistance is independent of the internal friction of the fluid. According to a theorem of du Buat, this may be represented by a supposed increase of the inertia of the fluid; and the same principle would apply to the case of ether. But in the case of pendular oscillations we must proceed to a higher order of approximation. The resistance of the solid to the fluid contains other very small terms, due to internal friction, which are proportional to the velocities, and the analogy holds here also in the case of ether. The symmetrical crystal considered has three rectangular planes of symmetry of which the intersections are taken for axes. If ξ, η, ζ denote the displacements due to vibration of ether the equations of motion are—

$$(1)\quad d^2/dt^2(\xi/a^2) + 2d/dt(a'\xi) = \Delta^2\xi - d/dx(d\xi/dx + d\eta/dy + d\zeta/dz)$$

with two corresponding equations with constants b, b', and c, c'. Here a, b, c, a', b', c' are six positive constants of which the last three are very small and vary as the period. To these have to be added respectively three terms to express the small resistance proportional to the velocity, namely, $d/dt(f\eta - e\zeta)$, &c., d, e, f being three constants, analogous to a', b', c', but having either sign. The writer then considers a system of pendular vibrations in plane waves. The amplitude U varies only with the distance u from a given plane—the surface of the crystal—whose normal is λ, μ, ν. The angles made with this normal by the normal to the wave are α, β, γ. Also ω is the velocity of propagation in the normal, $l = \cos\alpha/\omega$, $m = \cos\beta/\omega$, $n = \cos\gamma/\omega$. Thus he finds for ξ, η, ζ the symbolic expressions—

$$\xi = (e^{-fu}e^{[k(t-lx-my-nz)+\text{const.}]\sqrt{-1}}, \text{\&c.},$$

and replacing u by $\lambda x + \mu y + \nu z$, he writes—

$$l - f/k\lambda\sqrt{-1} = \mathrm{L}\,;\ m - f/k\mu\sqrt{-1} = \mathrm{M}\,;\ n - fk\nu\sqrt{-1} = \mathrm{N}\,;\ ce^{\sqrt{-1}\,\text{const.}} = \mathrm{L}'$$

and reduces the expressions to $\xi = \mathrm{L}'e^{k(t-\mathrm{L}x-\mathrm{M}y=\mathrm{N}z)\sqrt{-1}}$, &c. The expressions (L), &c., are subsequently written $l + \delta\mathrm{L}$, $m + \delta\mathrm{M}$, $n + \delta\mathrm{N}$, where $\delta\mathrm{L}$, &c., are very small imaginary quantities. In like manner he writes—

$$\mathrm{A} = a(1 + a^2a'\sqrt{-1}k) = a + \delta\mathrm{A}, \text{\&c.},$$

where $\delta\mathrm{A}$ is imaginary and very small. The final result is of the following form: If V be the angle between the normal to the wave and the vibration, and V′, V″ the angles made with the planes of equal amplitude, by the vibrations l, m, n, and the normal $\cos a$, $\cos \beta$, $\cos \gamma$, then f, the coefficient of absorption, is given by—

$$f = \omega \frac{a'l'^2 - b'm'^2 + c'n'^2}{\cos V'' - \cos V \cos V'}, = \omega \frac{a'l'^2 - b'm'^2 + c'n'^2}{\sin V \sin V' \cos V}$$

by a known proposition in spherical trigonometry. S. H. B.

1002. *Remarkable Radiation Phenomena.* **L. Graetz.** (Ann. d. Physik, 9. 5. pp. 1100–1110, Dec., 1902.)—von Branca noticed that when a sensitive plate is held, in the dark, film downwards, over hydrogen peroxide, and a flat copper cross is placed on the top of the plate, the image or shadow of the cross is found on the plate on development. This phenomenon is investigated, and is found to happen when precautions are taken to prevent the H_2O_2 vapour from getting above the plate. The image is also obtained when a sheet of paper, wood, or ebonite is interposed between the copper and glass, and is more distinct when a sheet of blotting paper soaked in water, alcohol, ammonia, petroleum, turpentine, or a salt solution is employed instead of the wood or ebonite. When one half of the plate is covered with paper soaked in ammonia, and the other with paper soaked in zinc sulphate, on the former the copper appears light on a dark ground, whilst under the zinc solution the image is dark on a lighter ground. In general non-metallic objects placed directly on the glass plate form no images, and the experiments with metals showed that that metal always gave the most distinct image, which was chemically attacked by the liquid. When two sensitive plates were placed one on top of the other, only the lower one, *i.e.*, the plate exposed to the H_2O_2, showed an image of the metal placed on the top, but an air layer of 2 mm. between the plates prevented formation of the image. On placing on the glass a metal vessel with water 10° hotter than the air, a similar effect to the previous ones was obtained, whilst with ice in the vessel the effect is reversed in character. The effect is ascribed to thermo-photography, although no temperature difference could be detected by means of a thermo-element. Some makes of photographic plates were better than others in respect to the distinctness of the image, Lumière plates sometimes giving no image at all. The H_2O_2 used was the commercial 3 per cent. liquid which appeared to be quite as effective as the chemically pure substance. G. E. A.

1003. *Radiation of Some Oxides.* **C. Féry.** (Annal. Chim. Phys. 27. pp. 433–548, Dec., 1902.)—The measuring apparatus had the form of a telescope with an object-glass of fluorine and a web made of an extremely fine iron wire crossed by and soldered to a similar one of constantan, thus constituting a thermocouple. Fluorine was chosen, as its absorptive power for radiation is constant within the range 900° to 1,500° C. The total radiation of twelve substances, including retort-carbon, platinum, and the oxides of chromium, zirconium, lanthanum, thorium and cerium, within the above range, was measured, and Stefan's law was found generally to represent the results, though in a few cases other values than 4 for the exponent of the temperature were found to be preferable. The luminous radiation was then measured by altering the brightness of the filament of an incandescent lamp, upon which an image of the radiating body was thrown, until it was not visible, the eye being armed with a screen which practically permitted only light of wavelength $0{\cdot}562\mu$ to pass. Wien's law was found in many cases to hold, but for some substances the radiation is better given by the expression $AT^{-x}e^{-K/T}$.

Variations of the radiation were observed and traced to the nature of the flame, and thence was deduced an explanation of the phenomenon of luminescence exhibited by oxides, viz., that there may be rapid oscillations of the temperature of the surface of the body whereby its radiation may become larger than that of a perfectly black body at the mean temperature. A simple theory was also deduced for the action of mixed oxides in forming the mantles of incandescent lamps, viz., that cerium oxide is a radiator as good as carbon, but not attaining a very high temperature unless its surface of contact with the flame is large, as when it is embedded in a transparent mass such as thorium oxide. R. E. B.

1004. *Doppler-Fizeau Experiment.* **A. Bélopolsky.** (Acad. Sci. St. Pétersbourg, Bull. 13. pp. 462–471, Dec., 1900.)—The principle underlying the construction of the author's apparatus for studying the Doppler-Fizeau principle has been described as far back as 1894 (see also Abstract No. 1265, 1901); he has since been able to complete the same. The principle of the apparatus is as follows: If a light source is placed between two parallel mirrors equidistant from both, it will easily be understood that the nth reflection lies at a distance $s=2nl$ from the light source, l being the distance of the illuminator from the mirror. If the distance between the mirrors undergoes temporary changes, $ds/dt=2n\,dl/dt$. In the case of the illuminator not lying on the middle line between the two parallel mirrors, the same result will be obtained, *i.e.*, its distance from the middle line will, in the differentiation, vanish as a constant quantity. This shows that even with small values of dl/dt (speed of the mirror), ds/dt (speed of the nth reflection) will be $2\,n$ times greater and may even attain very high values. For a speed of the mirror = 50 m. per sec., the 10th reflection will already occur with a velocity = 1,000 m. per sec. Now, according to a theorem given in Ketteler's Astronomische Undulations-theorie, the wave-length of monochromatic light will be modified after a reflection from a rotating mirror. The wave-length after reflection on the latter is given by the following equation: $\lambda_1=\lambda_0\,(1\pm 2v/V\,.\cos\psi)$. In this equation, λ_0 is the wave-length before the reflection, v the speed of the mirror, V the velocity of light, ψ the angle between the direction of motion of the mirror and a perpendicular on the latter. If therefore the beam of light be reflected by a number n of rotating mirrors, the final wave-length will, in the case of v being identical and ψ being a constant angle, be given with a sufficient approximation by the equation $\lambda_n=\lambda_0\,(1\pm 2nv/V\,.\cos\psi)$, the sign depending on the direction of motion of the mirror. This shows that the difference $\lambda_n-\lambda_0$ becomes a considerable quantity if n is sufficiently great, though v may be comparatively small. On the basis of the above-said an apparatus should be constructed, having parallel mirrors rotating in opposite directions at as high a speed as possible, the simplest device consisting of two wheels, both of which are fitted with some thick mirrors. The wheels turn rapidly in opposite directions, being connected to a toothed-wheel gearing, so that after a very short time any two of the mirrors will take parallel positions with regard to one another. The illuminator will allow of an infinite number of reflections being produced, one of which may be utilised for observations by means of a strong spectrograph. Each wheel has eight plane, silvered glass mirrors, and is mounted on the axle of two electric motors, giving a total of four machines. Each machine works at a pressure of 50 volts and with a current less than 3 amperes, the nominal number of revolutions being 6,000 per min.; two commutators serve to invert the direction of rotation of each pair of machines. The results recorded by the author embody the first attempt to determine the rotation of spectral lines without resorting to observations on celestial bodies. The author thinks his apparatus to be capable of further improvements allowing of more accurate determinations being made. A. G.

1005. *Beauty in Colour.* **F. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 901–922, July, 1902.)—The statistical method is employed to decide what colours are beautiful or otherwise. A large number of coloured papers, comprising many shades of red, yellow, green, blue and violet, were subjected to the examination of more than 200 persons, the majority of whom distinguished eighteen shades as being either beautiful or ugly. The cause is ascribed to physiological effects produced on the eye by the colours. Reasons are given for the decision that the eye prefers those colours which approach most nearly to the primary red, green and blue. The relative proportions of the primary colours in the above eighteen shades being determined by means of a König spectro-photometer, it is found that those shades which were designated as beautiful match the primary colours best. The colours of Oriental carpets and of precious stones exhibit a predominance of the primary tints, and tables and spectrum curves are given of measurements of the colours of ruby, emerald and sapphire, and it is found, for example, that the blue of the sapphire and that of the sky coincide almost exactly with that of primary blue, whilst the red of certain Persian carpets and that of the garment on the Raphael Madonna in Vienna coincide with the colour of primary red. G. E. A.

1006. *Photographic Development.* **A. Watkins.** (Soc. Arts, Journ. 51. pp. 42–48 ; Discussion, pp. 48–50, Dec. 5, 1902.)—The author surveys briefly the work of Hunter and Driffield, and considers the control of development by time, the comparative values of developers, the influence of bromide, and compensation methods for various exposures. He arrives at the conclusion that the variation of the composition of a developer, bromide excepted, does not influence the final result. Moreover, the bromide influence is not well under control, and cannot be exercised after all the tones have appeared ; bromide is best omitted from the developer, it being unnecessary. The influence of time is quite sufficient for all the control required. C. E. A.

1007. *Strain Theory of Photographic Action.* **J. C. Bose.** (Roy. Soc., Proc. 70. pp. 185–193, June, 1902.)—In this paper the author applies the results of his previous researches [see Abstracts Nos. 1052 and 1053 (1903)] to the formulation of a strain theory of photographic action. A substance, according to this theory, may be sensitive to light or other radiation, and yet be incapable of yielding a photographic image if the self-recovery is rapid. This would explain the obscure phenomenon of the relapse of the visible image. Recovery is merely a question of time. With certain substances it is immediate, with others rather more slow, as in a daguerreotype, where the latent image only disappears in the course of several hours. In ordinary photographic plates the recovery may not take place for several years. One of the chief functions of so-called sensitisers may be to prevent self-recovery and make the after-effect permanent. The continuing after-effect produced by overstrain explains the production of images by long-continued exposure, where a short exposure gives no result. For example, Moser obtained an invisible image, after two hours' exposure to the sun, on a clean silver plate, and a similar result has been obtained with copper. Waterhouse (Roy. Soc., Proc., April, 1900) in this way obtained images on lead and gold. A curve is given showing the action of light on one of the plates of a photo-electric Ag-Br cell. This shows a short latent period, where there is apparently little or no action or even a transitory negative action. This may explain the phenomenon known as photo-electric induction. For example, the action of light on a mixture of H and Cl requires time for a sensible quantity of HCl to be formed, and the rate of formation increases to a maximum. If the mixture has once been exposed to the light, it will retain in the dark, for about half an hour, its capacity for immediately beginning to form HCl in the light, and after remaining in the dark for a longer period than half an hour there will only be a short period of induction, as it was called by Bunsen, but this period will be lengthened by keeping the mixture longer in the dark. The so-called dark lightning photographs may be explained by the reversals produced by great overstrain. Curves are given illustrating the effects of intermittent and continuous illumination respectively on an Ag-Br cell. These afford an explanation of the photographic phenomenon of recurrent reversals.

G. W. de T.

1008. *Molecular Strain Theory of Vision and Photographic Action.* **J. C. Bose.** (Photographic Journal, 42. pp. 146–161; Discussion, p. 161, June 30, 1902.)—In this paper the author develops in somewhat more detail the subject dealt with in the preceding Abstract, and also propounds an electric theory of vision. According to this theory, the visual impulse is an electric impulse. The latter is already known to produce visual sensation. The nerve is a conductor, and the brain an extremely delicate detector, of electric current. Experimental evidence is given that such electric impulses are produced by the action of light on the retina, and that there is no necessity to assume the existence of electromotive elements in the retina. The author records the phenomenon, noted by him, that in the binocular vision of normal eyes, the visual effect in each eye fluctuates in such a manner that the sensation in one eye is complementary to that in the other, the sum of the two sensations remaining approximately constant. They therefore see and rest alternately. Methods of experimentally demonstrating this are described. This phenomenon, as well as the better known ones of recurrent vision, point to a process of after-oscillation, similar to that found in the sensitive cells employed in the author's investigations. [See also Abstracts Nos. 1052, 1053, and 1054 (1903).]

G. W. de T.

1009. *Variation of Double Refraction in Strained Glass with Wave-length.* **L. N. G. Filon.** (Cambridge Phil. Soc., Proc. 12. pp. 55–64, Jan. 23, 1903.)—A spectroscopic method is substituted for the one previously employed [see Abstract No. 415 (1903)], the light from an electric arc being broken up by two prisms, after passing through the Nicols and the glass block under pressure. Application of pressure causes the appearance in the telescope of two bands with a bright line spectrum in between, and observations are made from the dark bands which are produced when the difference in retardation between the two polarised rays passing through the glass block amounts to a whole wave-length. Taking $\lambda = C \times$ mean pressure $\div$ thickness of glass, C being called the stress-optical coefficient, three series of values of C and λ give a straight line curve, showing a steady decrease of C from λ 4,500 to λ 6,500, the total variation being about 5 per cent. The value of C found was $\{29{\cdot}69 - 0{\cdot}00070\,\lambda\} \times 10^{-8}$ sq. cm. per kg. weight, but the method is not an accurate one for determining the absolute value of this constant.

G. E. A.

1010. *Double Refraction and Convection.* **Rayleigh.** (Phil. Mag. 4. pp. 678–683, Dec., 1902. Paper read before Section A of British Association at Belfast.)—The author describes delicate experiments made to see if there was any double refraction due to the deformation suggested by Fitzgerald and Lorentz, as experienced by a solid moving with the earth through a stationary ether. The experiments on liquids proved conclusively that there is no double refraction of the order to be expected, that is, comparable with 10^{-8} of the single refraction. The experiments on solids offered much more difficulty, and hence the results were much less satisfactory, but the author considers that they were sufficient to justify the conclusion that there is, in their case also, no double refraction, of the order to be expected, due to motion through the ether. G. W. de T.

1011. *Optically Active β-Ketonic and β-Aldehydic Acid Esters.* **A. Lapworth** and **A. C. O. Hann.** (Chem. Soc., Journ. 81 and 82. pp. 1491–1508, Dec., 1902.)—Menthyl formylphenylacetate shows no tendency to persist in the ketonic form, and the authors have only been able to prepare one compound, which is believed to be the aldehydic modification. Indications are, however, present that equilibrium between the two forms is attained extremely readily in alcohol. With regard to mutarotation this exists perhaps in chloroform solution, but only to a very slight extent. No indications of stereoisomerism in the metallic derivatives of the ester can be found. Menthyl acetoacetate, prepared by heating together menthol and ethyl acetate, consists most probably of the ketonic modification, this conclusion being drawn from the following facts: (1) It has very feeble acidic properties; (2) its substituent is not an acyl group; and (3) its behaviour towards ferric chloride indicates that the maximum quantity of enolic ester is not present at the first moment of dissolution in a solvent. Menthyl acetoacetate exhibits mutarotation in non-oxygenated solvents, the change occurring with a speed which renders it easy to study the effect of various agents. The most striking feature is that traces of acids as well as bases accelerate the change evidenced by the mutarotation. In the case of many other active menthyl esters obtained from the formylacetate and acetoacetate, no observable change of rotation occurs. T. H. P.

1012. *Asymmetric Optically Active Selenium Compounds and the Sexavalency of Selenium and Sulphur, d- and l-Phenylmethylselenetine Salts.* **W. J. Pope** and **A. Neville.** (Chem. Soc., Journ. 81. and 82. pp. 1552–1563, Dec., 1902.)—The authors describe the preparation of phenyl methyl selenide, which reacts readily with bromoacetic acid giving phenylmethylselenetine bromide, $(CH_3)(C_6H_5):SBr.CH_2.CO_2H$. This externally compensated compound is separated into its two oppositely active constituents by treatment with silver *d*-bromocamphorsulphonate, and on examining the two salts obtained and allowing for the rotation of the *d*-bromocamphorsulphonic ion, it is found that the molecular rotation $[M]_D$ of the *d*-phenylmethylselenetine ion is $+60{\cdot}8^\circ$ and the value for the lævo-ion, $-60{\cdot}4^\circ$. The molecular rotations for the *d*- and *l*-platinichlorides are $+55{\cdot}0^\circ$ and $-54{\cdot}1^\circ$ respectively. In the formation of the mercuriodides it is found that optical inversion takes place so that the *d*- or *l*-selenetine yields the same mercuriodide as the *i*-compound. The same is found to be the case with a similar thetine compound examined by the authors. It is concluded that the mercury compounds of the sulphonium and selenonium bases probably contain sexavalent sulphur or selenium. T. H. P.

1013. *Use of the Diffraction-grating in the Study of the Ultraviolet Spectrum.* **R. Magini.** (Accad. Lincei, Atti, 11. pp. 305–311, Dec. 7, 1902.)—The author for his work on the ultraviolet rays required a spectrum which was very widely dispersed and was yet very intense. He found that such a spectrum could be obtained by using the Rowland grating in such a way as to make the angle of incidence as large as possible. It appears that an increase of the angle of incidence leads to an increase in the dispersion of the ultraviolet spectrum of the first order, so that, by notably increasing the angle of incidence, it is possible to obtain an ultraviolet spectrum of the first order with a dispersion equal to or greater than that possessed by the normal spectrum of the second order. D. H. J.

REFERENCES.

1014. *Electric Telephotography.* **S. Saubermann.** (Zeitschr. Elektrotechn., Wien, 20. pp. 452–456, Sept. 14, 1902.)—This is a summary of recent work on this subject. G. W. DE T.

1015. *Testing Muscles of Eyeball.* **W. S. Baxter.** (British Optical Journ. 2. pp. 21–24, Sept., and pp. 37–41, Oct., 1902. Paper read before the West Riding Optical Society.)—This is a useful compendium as to apparatus and methods for testing errors of vision due to weakness or spasm, &c., of the muscles controlling the eyeball. A. D.

1016. *Elementary Theory of Zeeman's Phenomenon.* **H. A. Lorentz.** (Archives Néerlandaises, 7. pp. 299–317, 1902. From the Versl. d. Kon. Akad. v. Wet. te Amsterdam, 8. p. 69, 1899.)—This is a French translation of the original article. In addition to setting forth the general theory, the article contains a reply to some objections which had been raised by Poincaré against the author's theory. [See also Abstracts Nos. 1657 (1900) and 756 (1901)]. G. W. DE T.

1017. *Theory of Phenomena of Light.* **A. Korn** and **K. Stoeckl.** (Ann. d Physik, 9. 5. pp. 1138–1148, Dec., 1902.)—This is a continuation of a former paper [see Abstract No. 2040 (1902)], and treats of the rotation of the plane of polarisation in magnetic fields, the starting point again being Faraday's supposition that magnetic particles rotate round their magnetic arcs with angular velocities which are proportional to their moments. G. E. A.

1018. *The Spectral Energy Curve of the Acetylene Flame.* **G. W. Stewart.** (Phys. Rev. 16. pp. 123–126, Feb., 1903.)—In a previous paper the author described the determination of the spectral energy curve of the acetylene flame by a modification of Paschen's method [see Abstract No. 293 (1902)]. This modification, however, was wrong, and the present paper contains the corrected results of some fresh measurements. E. C. C. B.

1019. *The Reproduction of Colours by Photography.* **H. E. Dresser** and **H. Trueman Wood.** (Nature, 67. pp. 127–129, Dec. 11, 1902.)—This article embodies a description of the three-colour photographic process used in photographing the eggs of European birds and also the subject matter of a demonstration given at the conversazione of the Royal Society on May 14. C. E. A.

HEAT.

1020. *Expansion of Fused Quartz.* **L. Holborn** and **F. Henning.** (Ann. d. Physik, 10. 2. pp. 446–448, Jan. 27, 1903. Communication from the Physikalisch-Technische Reichsanstalt.)—The expansion of a rod of fused quartz of 0·52 m. length and 2·9 mm. mean diameter, is determined for the ranges of temperature 17–250° C., 250–500° C., 500–750° C., and 750–1,000° C. At the ends are ground, parallel planes, which contain the axis of the rod, and the divisions necessary for observing changes in length are five fine lines, drawn with a diamond on these planes. These are observed by microscopes held by nickel-steel carriers. The rod was sufficiently straight for the experiment, but the cross-section was somewhat irregular. The values of the increase in length, together with the corrections applied, are given in the paper. The authors found the mean coefficient of linear expansion from 0° C. to 1,000° C. to be 0·00000054, instead of 0·00000059 given by Callendar for the same range. The results can be expressed nearly as closely by a linear as by a quadratic formula. [See Abstract No. 2355 (1901).] The possibility of a change in the rate of expansion at temperatures above 500° C., corresponding to the great change found by Le Chatelier in natural quartz, is not excluded by these experiments. It is certain, however, that the expansion is not so irregular as that found by Le Chatelier. The after effect of heating was not observed. S. G. S.

1021. *Temperature-changes during Stretching and Torsion of Wires.* **A. Wassmuth.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 996–1012, July, 1902.)—An improvement by A. Naumann of Wassmuth's apparatus (in which a number of equal short wires, connected by hard wooden blocks, are substituted for a single long wire, and a number of thermo-elements in series, one soldered to each short wire, are employed to magnify the temperature-effect) is here described, together with the results of some stretching experiments on steel wires; these conform to Kelvin's formula. A similar improvement by Naumann of Wassmuth's apparatus, in which equal torsions can be given to three equal wires to which are soldered three thermo-elements in series, is also described, and torsion experiments made with it on steel wires agree with Kelvin's torsion formula. The author proposes, by using this last apparatus, to determine the rates of variation with temperature of the moment of torsion and of the rigidity of wires, Kelvin's formula being assumed, and the cooling effects of torsion being measured; and he further suggests a way of determining the rate of variation of Young's modulus for a rod, by supporting it with free ends, suddenly loading it at its middle point, and noting the consequent temperature-change. R. E. B.

1022. *Gas Explosions in a Closed Vessel.* **L. Bairstow** and **E. C. Horsley.** (Engineering, 74. pp. 723–724, Nov. 28, 1902. Paper read before the British Association meeting at Belfast (Section C).)—The explosion cylinder—a wire-wound steel casting 16·5 in. in diam. and 20·5 in. long externally—is capable of withstanding working pressures up to 1,500 lbs. per sq. in. The covers are flat on the inside, leaving an internal cylindrical space 10 in. in diam. and 18 in. long, with a capacity of 1,419 c. in. In the centre of the upper cylinder cover is an indicator of the "Simplex" type. Ignition is by spark near the upper cylinder cover. The calorific value of the gas used is 272 lb. Cent. heat units per cubic foot. The results of the two series of experiments are given in Tables I. and II. The mixture is taken as the ratio of the volume of the gas introduced to that of the air present. Another series of experiments was commenced on the same mixtures at atmospheric pressure, and after allowing time for cooling, the pressure was read on a mercury gauge connected to the cylinder. The loss from atmospheric pressure is given in Table I. This loss will be proportional to the amount of gas burnt.

TABLE I.—*Initial Pressure,* 14·7 *Lb. per Square Inch Absolute.*

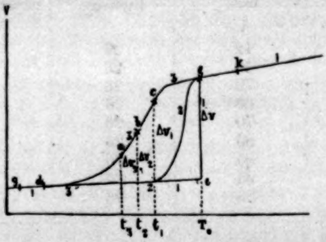
Mixture.	Maximum Final Gauge Pressure. Pounds per Square Inch.	Temperature. (Centigrade) before Explosion.	Contraction as Measured by Loss of Pressure in Inches of Mercury.
0·065	12	23	0·76
0·101	50	26	3·86
0·140	72	26	5·12
	69	26	
	70	26	
0·181	85	25	6·20
	85	25	
0·226	92	25	
0·273	89	23	

TABLE II.—*Initial Pressure,* 20·4 *Lb. per Square Inch Absolute.*

Mixture.	Maximum Final Gauge Pressure. Pounds per Square Inch.	Tem perature (Centigr ade) before Explosion.
0·097	63	26
0·123	103	26
0·158	120	26
0·183	129	25
0·215	129	25
	132	25
	132	25
	130	25
0·249	129	25
	128	25

More experiments are being performed with modified apparatus. C. C.

1023. *Extrapolating Melting-points of Chemically Homogeneous Substances.* **W. Soboleff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 7a. pp. 714–720, 1902.)—The melting-points for the same substance, as given by different authors, often show departures of as much as several degrees from one another, and, though we may give a preference to the highest figure with some degree of probability that this refers to the *pure* substance, there still remains some doubt as to whether really the ideally pure body is concerned. In order to determine the melting-point of a body, one has generally to purify the given substance by repeated crystallisation. Now, in this operation, the amount of substance available will frequently be so diminished that the experimenter is compelled to stop it at the very point where his predecessors had to discontinue it. In order to check the chemical homogenity of a given specimen, as well as to determine the melting-point of the ideally pure substance, Tammann suggested to the author the following method: If the melting process of a body be represented by plotting the variations of volume as ordinates and the variation in the temperature as abscissæ, we shall, in the case of an absolutely pure body, obtain on the diagram the curve (1, 1, 1), where at one given temperature T_0 the whole of the given amount of liquid will be melted. If, however, another substance be added, melting will occur, instead of at one given temperature, within a whole interval of temperatures, as illustrated by the curves (2, 2, 2) and (3, 3, 3) of the same diagram. The normal drawn on the prolongation of the part corresponding to the solid substance, from the point *e* of the curve, where the whole of the latter has assumed a molten condition, represents with a fair approximation the variation Δv in the volume of the substance as occurring on its passage from the solid to the liquid state. For any one of the points of the curve (3, 3, 3) representative of a heterogeneous substance, partly in a solid and partly in a liquid condition, we may determine the concentration of the mixture for which at a certain temperature the molten substance is in equilibrium with the crystals. Assuming that the added substances do not form any solid solutions with the crystals, and their concentration, as the whole of the body is molten, to be x, we shall have, at the temperatures t_1, t_2 and t_3, respectively, the concentrations—



$$x\,\Delta v/\Delta v_1,\; x\,\Delta v/\Delta v_2, \text{ and } x\,\Delta v/\Delta v_3.$$

Let the true melting-points of the substance in question be T_0, then the lowering of the melting-point corresponding to each of the concentrations will be $T_0 - t_1$, $T_0 - t_2$, $T_0 - t_3$, respectively. Assuming the lowering to be proportional to the concentration of the added substances, we have—

$$\frac{T_0 - t_1}{x\frac{\Delta v}{\Delta v_1}} = \frac{T_0 - t_2}{x\frac{\Delta v}{\Delta v_2}} = \frac{T_0 - t_3}{x\frac{\Delta v}{\Delta v_3}} = \ldots\ldots\ldots\ldots\ldots\ldots = \text{const.}$$

Hence—

$$T_0 = \frac{\Delta v_1 \,.\, t_1 - \Delta v_2 \,.\, t_2}{\Delta v_1 - \Delta v_2}$$

A dilatometer, devised by the author according to the hypotheses made with the above deductions, is illustrated. In order to determine the diagram shown in the figure, there should be known seven points at the least, corresponding to the points *g* and *d* *x*, also *a*, *b* and *c* on the part of the curve showing the variation in volume during the fusion of the substance, and, finally, to the points *c* and *h*, respectively. The above method has been applied to the following bodies: Orthocresol, diphenylamine, naphthaline, vaniline. The results give evidence of the fact that though rather impure substances were used, the melting-points of which were at least 1° C. below those given by other authors for the pure body, yet the ideal melting-points, as determined for these substances by means of the above graphical method, are all sensibly superior to the latter. A. G.

1024. *Aluminium near the Fusing-point.* **A. Granger.** (Chem. News, 86. p. 284, Dec. 12, 1902. Bull. Soc. Chim. Series 3, vol. 27, No. 25.)—The author points out that, at a temperature of 600° C., aluminium becomes granular and can be broken with ease; as the temperature is further increased, it assumes a pasty condition before melting. In this condition it is easily cut with an ordinary knife. The cut surface is then granular in structure, and small quantities at a time can be powdered in a mortar like zinc.

G. W. DE T.

1025. *Mean Isometric Pressure-Coefficient between 0° and 100° C. of Hydrogen and Helium: Vapour Pressures of Liquid Oxygen and Hydrogen.* **M. W. Travers, G. Senter,** and **A. Jaquerod.** (Roy. Soc., Phil. Trans. 200. pp. 105–180, Dec. 6, 1902. Roy. Soc., Proc. 70. pp. 484–491, Sept., 1902. Abstract.)—A careful description is given of the apparatus used, the methods employed, and the precautions taken both in the preparation of the gases and in the measurements made. For hydrogen the measures give $10^8 \alpha - 366200 = 18$ [there is a slip of calculation in the paper], 68, 53 respectively for mean initial pressures 348, 520, 699 mm.; but the authors conclude that on the whole α does not really vary with the pressure and that its value is 0·00366255 = 1/273·03. Their conclusions are exactly the same for helium, their measures giving $10^8 \alpha - 366200 = 84$, 55 respectively at the mean initial pressures 523,681 mm. For liquid oxygen the B.P. on the helium scale was found to be —182·83°, and the vapour pressure varied from 800 mm. at —182·33° to 150 mm. at —195·86°. The hydrogen thermometer gives readings 0·1° lower at these temperatures, which are on the average only 50° above the critical point of H, while 75° above that of helium. Liquid oxygen cannot be maintained in a steady state of ebullition unless a rapid current of the gas is passed through it, as it tends to become superheated. Liquid hydrogen, on the contrary, boils steadily; its B.P. was found to be —252·62° on the helium scale and its F.P. —258·93°, at which its vapour pressure is 49 mm., being 800 mm. at —252·43°. At these temperatures the hydrogen thermometer reading is about 0·2° lower than that of the helium thermometer. Incidentally the vapour pressure of solid neon was measured and found to be 12·8 and 2·4 mm. respectively at —252·63° and —257·38° on the helium scale; and conjectures are made as to the critical- and boiling-points of helium and neon. R. E. B.

1026. *Equation of the Saturation-Curve and the Maximum Work of Vaporisation.* **P. Ritter.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 1046–1052, July, 1902.)—The equation of the "reduced" saturation-curve on van der Waals' theory is found very neatly, and thence are calculated the circumstances under which the work of vaporisation is a maximum. This occurs for reduced pressure 0·2006 and reduced temperature 0·6999, the reduced volumes in the liquid and vapour states being then 0·4672 and 7·8054. R. E. B.

1027. *Mixtures of Constant Boiling-point.* **S. Young.** (Chem. Soc., Journ. 83 and 84. pp. 77–83, Jan., 1903.)—Thorpe has described a mixture of carbon tetrachloride and methyl alcohol, which boiled constantly at 55·6–55·9°, and had the composition, deduced from its vapour density, CCl_4 78·1, CH_4O 21·9 per cent. The author finds that the boiling-point of the mixture is 55·70° at

760 mm. and its composition, deduced from specific gravity, 20·56 per cent. CH_4O; determination of its composition by observing the weight of distillate coming over below the middle temperature (*i.e.*, the mean of the boiling-points of the constant mixture and that of the constituent present in excess) gave 20·65 in two determinations with CCl_4 in excess, and 20·01 with CH_4O in excess; the low value in the latter case is perhaps due to the greater difficulty of separating the constant mixture from excess of alcohol. T. M. L.

1028. *Freezing-point Depression in Electrolytic Solutions.* **J. Walker** and **A. J. Robertson.** (Roy. Soc. Edinburgh, Proc. 24. pp. 363–379, 1902–1903.) —The authors have determined the freezing-points of solutions under conditions involving a different systematic error from that encountered when the ordinary method of procedure is followed. The freezing tube consisted of a Dewar vacuum vessel, and instead of, as in the ordinary method, allowing a small quantity of ice to crystallise out from a solution of known concentration, the authors added to the solution a relatively large amount of ice, and after the equilibrium temperature had been attained, filtered off the solution and determined the concentration by analysis. The temperatures could be determined with an accuracy of about 0·0002–0·0003°, and the error of analysis did not amount to more than 0·2 per cent. To test the validity of the method for determining ionisation values, several experiments were made with malonic acid which obeys Ostwald's dilution law, and an absolute agreement was found between the values calculated from the conductivity experiments, and those obtained by the cryoscopic method. The ionisation values of hydrochloric acid, potassium chloride, and sodium chloride were determined, acetic acid being employed as standard of reference, and the following values were obtained :—

	HCl.	KCl.	NaCl.
From conductivity at 0° (MacGregor)	0·956	0·892	0·877
From freezing-point	0·908	0·854	0·874

Except in the case of sodium chloride, there are therefore great divergences between the ionisation values calculated from cryoscopic and electrical observations. It is seen also that, in accordance with other observers, sodium chloride was found by the cryoscopic method to be more highly ionised than potassium chloride, whereas by the conductivity method the reverse is apparently the case. The results obtained agree very well with those of other investigators. A. F.

1029. *Boiling-point, Freezing-point, and Vapour Pressure of Pure Nitrogen at Low Pressures.* **K. T. Fischer** and **H. Alt.** (Ann. d. Physik, 9. 5. pp. 1149–1185, Dec., 1902. From the Sitzungsberichte der Kgl. bayer. Akad. der Wissenschaften, Mathem.-Phys. Klasse, p. 113, 1902.)—The authors' measurements, made with the aid both of a hydrogen thermometer and of a copper-constantan thermo-element, show that the boiling- and solidifying-points of pure liquid nitrogen serve as very definite standards for low-temperature measurements. The methods of preparation, purification, and liquefaction of the nitrogen are described fully; great care is necessary to prevent access of oxygen from the air, as a very slight contamination causes an appreciable rise in the boiling-point of the nitrogen. The liquid employed by the authors contained not more than 0·3 per cent. of impurities, and gave the following constants: Boiling-point, $-196·17°$ C. $\pm 0·05°$ at 715 mm. pressure, and $-195·67°$ C. $\pm 0·05°$ at 760 mm. pressure; solidifying-point,

$-210{\cdot}52^\circ$ C. $\pm 0{\cdot}2^\circ$ at a pressure of 86 ± 4 mm. Curves and tables are also given showing the vapour pressure of liquid nitrogen at low temperatures. The numbers obtained agree well with Dühring's boiling-point formula $(t' - t'_0)/(t - t_0) =$ a constant (where t_0 and t'_0 are the boiling-points of two substances at some particular pressure, and t and t' at some other pressure), and also with the Ramsay-Young formula. The heats of vaporisation of liquid nitrogen at different pressures, calculated from Clapeyron's formula, are also given. T. H. P.

1030. *Thermochemistry of Metaphosphoric Acid.* **H. Giran.** (Comptes Rendus, 135. pp. 1333–1335, Dec. 29, 1902.)—The results of the author's measurements of the heat developed by the transformation of meta- into ortho-phosphoric acid by means of sulphuric acid are as follows: HPO_3 (solid) + H_2O (liquid) = H_3PO_4 (solid) + 10·22 cals. The heat of solution of the solid meta-acid is + 9·76 cals., and that of fused sodium meta-phosphate + 3·97 cals. The heat of neutralisation of dissolved metaphosphoric acid by sodium hydroxide is + 14·84 cals. These numbers lead to the following: HPO_3 (solid) + Na (solid) = $NaPO_3$ (solid) + H + 63·03 cals. The corresponding reaction with the pyro-acid gives 54·11 cals., and that with the ortho-acid 49·38 cals. The heat of formation of metaphosphoric acid from its elements is calculated to be approximately 234·64 cals. T. H. P.

1031. *Thermochemistry of Quinine and Quinidine.* **Berthelot** and **Gaudechon.** (Comptes Rendus, 136. pp. 128–139, Jan. 19, 1903.)—The results of a number of thermochemical measurements of quinine and quinidine are given, the heats of formation from their elements being + 50·5 and + 51·2 cals. respectively. The heats of combustion and neutralisation are also practically the same in the two cases. With quinine, the mono-acid salts show in solution approximately the same heats of neutralisation. The second equivalent of acid developes less heat than the first, so that the two valencies of quinine are not equal. The heat of formation of the solid monohydrochloride approaches that of ammonium chloride. Also on comparing the difference between the heats of formation of the sulphate and acetate of quinine on the one hand, and of inorganic bases on the other, it is found that, as regards its basic properties, quinine may be compared with the alkalis. T. H. P.

1032. *Thermochemistry of Cinchonine, Cinchonidine, and Cinchonamine.* **Berthelot** and **Gaudechon.** (Comptes Rendus, 136. pp. 181–186, Jan. 26, 1903.)—The heats of formation of cinchonine, cinchonidine, and cinchonamine from their elements are 4·7, 4·95, and 23·4 cals. respectively. Cinchonine and cinchonidine show approximately the same heats of neutralisation and combustion, and both are weaker bases than quinine. For cinchonamine, however, the numbers obtained are comparable with the corresponding ones for quinine. T. H. P.

1033. *Internal Latent Heat.* **G. Bakker.** (Ann. d. Physik, 9. 5. pp. 1128–1132, Dec., 1902.)—The author's theorem, that the internal latent heat is proportional to the difference between the densities of the liquid and vapour, was deduced from Gauss's theory of capillarity and not, as is frequently stated, from van der Waals' equation, the applicability of which to a liquid is indeed doubtful; and the theorem should be quoted with the condition that the molecule has the same size and form in both the liquid and gaseous states. The proportionality is not therefore exact except perhaps for monatomic substances, and $\lambda/(\rho_1 - \rho_2)$ is in no way measured by the capillary constant. R. E. B.

1034. *Latent Heat.* **K. Hällstén.** (Zeitschr. Phys. Chem. 42. pp. 369–374, Dec. 23, 1902.)—The excess ρ of the latent heat λ over the external work of change of state fu, where f is the saturation-pressure and u the change of volume on change of state, is of the character of an internal work and $\chi \equiv \rho/u$ is of the character of an internal pressure, which, depending on the temperature only, is constant during the whole change of state, and is $(d \log f/d \log T - 1)$ times the saturation-pressure (since $\lambda = uTdf/dT$). Calculations from Regnault's data for 8 liquids show that χ is greater than p and increases with T, while χ/p diminishes as T increases; and the data for the melting of Hg, Pb, and H_2O under atmospheric pressure point to an internal pressure of several tens of thousands of atmospheres. R. E. B.

1035. *The Possible Duty of Fuel.* **H. Friedenthal.** (Deutsch. Phys. Gesell., Verh. 4. 18. pp. 387–396, Dec. 12, 1902.)—More of the energy of fuel can be transformed into mechanical work in machines with properly chosen non-cyclical processes than with a Carnot cycle. In a discussion **Planck** pointed out that no general expression for the efficiency of a machine can be formulated if the processes of its working are not cyclical. R. E. B.

1036. *Clausius' Inequality and Permanent Changes.* **K. v. Wesendonck.** (Ann. d. Physik, 9. 5. pp. 1133–1137, Dec., 1902.)—The deduction of Clausius' inequality from Duhem's theories for systems subject to hysteresis, &c., is no demonstration of the inequality, but a test of the goodness of the theories; and these, though giving in many respects an excellent picture of the phenomena, cannot be regarded as a final solution of the problems. The inapplicability of the inequality to false cyclical processes is not a ground for surprise. R. E. B.

REFERENCES.

1037. *Thermoelectric Evaluation of Absolute Temperatures.* **Ponsot.** (Comptes Rendus, 135. pp. 954–956, Dec. 1, 1902.)—A simple method of employing the relations given in Abstract No. 568 (1903) for the determination of absolute temperatures is here explained, but the possible error of the method is not evaluated. R. E. B.

1038. *Pfaundler's Calorimeter.* **W. F. Magie.** (Amer. Phys. Soc., Bull. 2. pp. 72–74, 1902 (Abstract).)—A study of this instrument and the niceties to be observed in its use. R. E. B.

1039. *Annealing of Muntz Metal.* **E. A. Lewis.** (Soc. Chem. Ind., Journ. 22. pp. 12–15, Jan. 15, 1903.)—Photographs are given showing the effect on the structure of Muntz metal of heating to 450°, 600°, 700°, and 800°, and then annealing or chilling. The metal had the composition Cu 61·49, Pb 0·24, Sn absent, Fe 0·02, Zn 38·25 per cent. T. M. L.

1040. *Reck's Hot-water System of Heating.* **H. Fischer.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1363–1365, Sept. 6, 1902.)—A description of the arrangement employed by Reck to prevent the gurgling noise that frequently accompanies heating by hot water. R. E. B.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1041. *Field of Electric Charge Moving Uniformly in a Circle.* **G. Picciati.** (Accad. Lincei, Atti, 12. pp. 41–47, Jan. 18, 1903.)—The electric charge m is supposed to move in an indefinite unpolarisable dielectric. According to the usual notation the electric force has components X, Y, Z, the magnetic force L, M, N ; 1/A denotes the velocity of light in ether. Hence the equations are the usual $\mathrm{A}d\mathrm{X}/dt = d\mathrm{M}/dz - d\mathrm{N}/dy$, &c., and $\mathrm{A}d\mathrm{L}/dt = d\mathrm{Z}/dy - d\mathrm{Y}/dz$, &c. The essential characteristic of the treatment of the problem is that the writer uses the "retarded potential" of Levi-Civita (Rendiconti, vol, 12, 1 Sem, 1903). Let namely the plane of the circular motion be that of $x\,y$, and the origin be the initial position of the charge m, R the radius of the circle, ω the angular velocity round the centre. Then if $\phi\ \psi$ be the coordinates of the point Ω at which the charge is at time t, $\rho_1 = \mathrm{R}(1 - \cos\omega t)$ $\psi = -\mathrm{R}\sin\omega t$. Introducing now Levi-Civita's retarded potential, let Ω' be the point at which the charge was at time $(t - \mathrm{A}r)$, where r is the distance from Ω' to the point x, y, z, at which the potential is sought. That is—

$$r^2 = \left\{x - \mathrm{R} + \mathrm{R}\cos\omega(t - \mathrm{A}r)\right\}^2 + \left\{y + \mathrm{R}\sin\omega(t - \mathrm{A}r)\right\}^2 + z^2.$$

Also F, the vector potential, is $\mathrm{F} = m/r(1 - \mathrm{A}v\cos(vr))$, v being the velocity of the charge, and its components are—

$$\mathrm{U} = \mathrm{AF}\frac{d\phi}{dt} \quad \mathrm{V} = \mathrm{AF}\frac{d\psi}{dt} \quad \mathrm{W} = 0.$$

From these data the author obtains by usual mathematical methods expressions for the electric and magnetic forces. The magnetic force is parallel to the plane of motion of the charge, and at right angles to the projection of the electric force on that plane. It is understood that the velocity of the moving charge m is less than that of light. [See also Abstract No. 456 (1903).] S. H. B.

1042. *Sound Waves and Electromagnetics. Pan Potential.* **O. Heaviside.** (Nature, 67. pp. 202–203, Jan. 1, 1903.)—Referring to the Boys' experiment showing the existence of a mass of air pushed in front of a bullet, the author asks whether there is anything analogous in the electromagnetics of an electron. The question is interesting in connection with Bjerknes' theory of pulsation in a liquid, which, if the liquid be incompressible, shows analogy to statical phenomena in electromagnetism. He considers the case of its being compressible. If the pulsations be not too frequent, the results will be nearly the same. But if they are very rapid, and the speed of propagation sufficiently reduced, new phenomena with pulsating sources will present themselves, and are they analogous to electromagnetic phenomena? If $q = d/d(vt)$, the velocity potential V is characterised by $(\mathrm{V}^2 = q^2)\mathrm{V} = -f$, where f is the density of the source; and if the speed of propagation be v, Q the strength of a point source, $\mathrm{V} = \epsilon^{-qr}\mathrm{Q}/4\pi r = \mathrm{Q}\left(t - \frac{r}{v}\right)/4\pi r$. If Q has a velocity u of its own in direction making angle θ with r, this becomes $\mathrm{V} = \mathrm{Q}/4\pi r(1 - u\cos\theta/v)$. This expression is like the motion of an electron through ether. But the analogy does not extend far. The results are discussed of making u greater or less than v, and of making the speed vary. The use of the word "potential" suggests to the writer a disquisition on "Pan-potential." $V = \Sigma\, e^{-qr} f/4\pi r = \text{pan}\, f$ is the definition for V due to a distributed source f — and q is given its most general signification, $q = (k + cp)(g/\mu p)$, the form for electromagnetic waves in a conductor. If C is the impressed electric current, H magnetic force, he finds ($q^2 = V^2$) $H = -\text{curl}\ C$; whence $H = \text{pan curl}\ C$; $= \text{curl pan}\ C$; and so on. S. H. B.

1043. *Conducting Sphere, surrounded by a Concentric Spherical Shell of Isotropic Dielectric.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 593–614, May and June, 1902.)—This electrostatic problem is treated by the usual well-known methods. The conducting sphere is of radius a_1 and insulated; the radius of the inner surface of the shell is a_2, that of the outer a_3. The constant of the dielectric is D. The author finds that the capacity, C, of the conducting sphere, instead of a_1, is, under the circumstances—

$$C = a_1 \Big/ \left(1 - \frac{D-1}{D}\frac{a_1}{a_2} 1 - \frac{a_2}{a_3}\right)$$

Three special cases are considered: (1) that the field external to the dielectric shell is homogeneous; (2) the presence of a single electric charge $+e$ at a certain distance; (3) the conducting sphere is surrounded by a concentric spherical conducting shell connected to earth. S. H. B.

1044. *Electrical Separation of a Metal from Gangue.* **D. Negreano.** (Comptes Rendus, 135. p. 1103, Dec. 15, 1902.)—If a powdered mixture of red lead and sulphur be blown through a finely perforated wooden disc and thence on to a metal plate with a central disc cut out of it, the plate and disc being connected by wires to the poles of a Wimshurst machine, a separation of the red lead and sulphur takes place, as one of the two substances adheres to the disc and the other to the plate. A similar method is proposed for the extraction of gold from auriferous sand. T. H. P.

1045. *Atmospheric Electricity.* **S. G. Egoroff.** (Acad. Sci. St. Pétersbourg, Bull. 14. pp. 463–468, April, 1901.)—The Pavlovsk magnetic and meteorological observatory is the only one in Northern latitudes where regular observations on atmospheric electricity have been carried out for many years, under rather favourable conditions for similar determinations (in Public Gardens, far from factories, the distance from the nearest railway being upwards of 2 versts). As, during bright and dry weather, the phenomena of atmospheric electricity are remarkable for their constancy and regularity, the author confines himself in this first attempt of a systematic record of the observations on atmospheric electricity, made in the above observatory from 1888 to 1897, nearly exclusively to days with bright and dry weather. From the tables given in this paper, the following conclusions are drawn: there are 2 minima and 2 maxima, the time of the morning minima being about the same both in summer and winter; the minimum observed in the afternoon is in winter weaker than the morning minimum, and in summer, on the contrary, stronger. The morning maximum in cold weather takes place later, and the evening maximum earlier, than during the hot season of the year. One of the peculiarities of the curves obtained in Pavlovsk consists in the morning maximum being superior to the evening maximum during the winter, and the day minimum very low. A. G.

DISCHARGE AND OSCILLATIONS.

1046. *The Electric Arc.* **Mrs. H. Ayrton.** (Roy. Soc., Phil. Trans. 199. pp. 299–336, Oct. 15, 1902. Roy. Soc., Proc. 68. pp. 410–414, Sept. 12, 1901 (Abstract).)—In this paper the authoress shows, on the basis of experimental evidence already set forth by herself, Duddell [see Abstract No. 850 (1901)], and others, that, by applying the ordinary laws of resistance, of heating and cooling, and of burning, to the arc, considered as a gap in the circuit furnishing its own conductor by the volatilisation of its own material, all its principal phenomena can be accounted for, without the aid of a large back e.m.f., or of a "negative resistance," or of any other unusual attribute. It is shown how volatilisation may begin, even without the self-induction to which the starting of an arc, when a circuit is broken, is usually attributed; and it is pointed out that, when the carbons are once separated, all the material in the gap cannot retain its high temperature. The arc is maintained to consist of (1) a thin layer of carbon vapour issuing from the end of the positive carbon, (2) a bulb of carbon mist joining this to the negative carbon, and (3) a sheath of burning gases, formed by the burning of the mist, and the hot ends of the carbons, and surrounding both. The flame is found to be practically insulating, so that nearly the whole of the current flows through the vapour and mist alone. It is suggested that the vapour has a high specific resistance compared with that of the mist, and that it is to the great resistance of this vapour-film that the high temperature of the crater is due, and not to any large back e.m.f. of which it is the seat. Volatilisation can only take place at the surface of contact between the vapour-film and the positive carbon. When that surface is smaller than the cross-section of the end of the carbon, it must make a pit. The sides of the pit, however, must be hot enough to burn away where the air reaches them, hence there is a race between the volatilisation of the centre of the carbon and the burning of its sides that determines the shape of the carbon. When the arc is short, the air cannot get so easily to the sides of the pit, hence it remains concave. When the arc is long, the burning of the sides gains over the volatilisation of the centre, and the surface of volatilisation becomes flat, or even slightly convex. The peculiar shaping of the negative carbon is shown to be due to its tip being protected from the air by the mist, and its sides being burnt away under the double action of radiation from the vapour-film and conduction from the mist, to a greater or less distance, according to the length of the arc and the cross-section of the vapour-film. It is shown that if the crater be defined as being that part of the positive carbon that is far brighter than the rest, then the crater must be larger, with the same current, the longer the arc, although the area of the volatilising surface is constant for a constant current. By considering how the cross-section of the vapour-film must vary with the current and the length of the arc, it is found that its resistance, f, must be given by the formula $f = h/A + (k + m)/A^2$, where h, k, and m are constants, l is the length of the arc, and A the current. This is the same form as was found by measuring the p.d. between the positive carbon and the arc by means of an exploring carbon, and dividing the results of the corresponding currents. Hence the existence of a thin film of high-resisting vapour in contact with the crater would not only cause a large fall of potential between the positive carbon and the arc, exactly as if the crater were the seat of a large back e.m.f., but it would cause that p.d. to vary with the current and the length of the arc exactly as has been found by measurement. The resistance of a solid carbon arc, apart from that of the vapour, must depend entirely on the cross-section of the mist. The mean cross-section of the mist was found to increase more rapidly than the current, consequently its resistance diminishes more rapidly than the current increases. As the formula for the resistance of the vapour-film shows that it too diminishes faster than the current increases, it follows that the whole resistance of the arc does the same, and that consequently the p.d. must diminish as the current increases. Hence if δV and δA be corresponding increments of p.d. and current, $\delta V/\delta A$ must be negative. It is found that the connection between m, the resistance of the mist, and the current is of the form $m = \alpha/A + \beta/A^2$. If m varies directly with the length of the arc, then $m = C(\alpha/A + \beta/A^2)$, and the total resistance of the arc will be $f + m = r = (p + ql)/A + (s + tl)/A^2$, the form found by dividing direct measurements of the p.d. between the carbons by the corresponding currents. Hence there is no reason why this ratio should not represent the true resistance of the arc. When the current is changed, it takes some time for the vapour-film to alter its area to its fullest extent, and still more time for the carbon ends to change their shapes, meanwhile the arc resistance, and consequently the p.d., must be altering also. Both these therefore depend, not only on the current and the length of the arc, but also, till the arc is "normal" again, on how lately a change has been made in either. At the first instant after a change of current, before the volatilising area has had time to alter at all, δV and δA must have the same sign, just as they would if the arc were a wire, but as the volatilising surface alters, the sign of δV changes. If therefore a small alternating current is applied to the direct current of an arc, it will depend on the frequency of that current whether $\delta V/\delta A$ is positive or negative. When the frequency is so high that the volatilising surface never changes at all, $\delta V/\delta A$ will measure the true resistance of the arc, unless it has a back e.m.f. which varies with the alternating current. The measurements of the true resistance made in this way by various experimenters have given very various results, because probably the frequency of the alternating current employed has been too low not to alter the resistance. A curve is drawn showing how the value of $\delta V/\delta A$, with the same direct current and length of arc, varies with the frequency, and it is pointed out that, even if the arc has as large a back e.m.f. as is usually supposed, the true resistance cannot be measured with a frequency less than 7,000 ∿. The exact conditions under which the true resistance can be measured in this way are examined, and the precautions necessary to ensure the fulfilment of these conditions are enumerated. A core in either or both carbons has a great effect on both the p.d. between the carbons and the change of p.d. that accompanies a given change current. It lowers the first, and makes the second more positive. It was found that the mean cross-section of the mist with a given current was largest when both carbons were solid, less when the negative carbon alone was cored, less still when the positive alone was cored, and least when both were cored. Coring either the positive carbon alone, or both carbons, had the same effect on the cross-section of the vapour-film as on that of the mist, but coring the negative alone only diminished this cross-section immediately after a change of current, but not when the arc had become normal again. Hence it is deduced that if the cores altered the cross-sections of the arc only, they would increase its resistance, and consequently the p.d. between the carbons. As they lower this, however, they must do it by lowering the specific resistance of the arc more than they increase its cross-section. The vapour and mist of the core must therefore have lower specific resistances than the vapour and mist of the solid carbon. When it is the positive carbon that is cored, all the vapour and mist come from the cored carbon. When the negative, they come from the uncored carbon, and it is only because the metallic salts in the core have a lower temperature of volatilisation than carbon, that the mist is able to volatilise these, and so lower its own specific resistance. The effect of a core in either carbon, or in both, must depend on the current, because the larger the current the more solid carbon will the volatilising surface cover, and the less therefore will the specific resistances of the mist and vapour be lowered. The way in which the core acts in each case is traced, and the alterations in the specific resistances and cross-sections due to the core are shown to bring about changes in the p.d. exactly similar to those found by measurement. The alterations in the value of $\delta V/\delta A$ introduced by the cores are next discussed, and it is shown that the changes in the resistance of the arc that must follow the observed changes in the cross-section, coupled with the alteration that must ensue from the lowering of its specific resistance, would modify $\delta V/\delta A$ exactly as Frith and Rogers (Phil. Mag., 1896, vol. 42, p. 407) found by direct measurement. [See also Abstract No. 118 (1901)].

G. W. DE T.

1047. *Duddell Circuits.* **A. Banti.** (Elettricista, Rome, 12. pp. 1–16, Jan., 1903.)—A Duddell circuit is a branch passing the poles of an electric arc and containing a capacity and an inductance. A capacity of about 10 microfarads and an inductance, consisting of a small transformer with open magnetic circuit, on the primary of which acted the microphone with its battery, served excellently for making the arc (direct current) reproduce sounds acting upon the microphone, when the arc was rather long and tranquil, between carbons of soft paste. When the microphone was removed and hard carbons were used and the arc shortened, the arc began to whistle, the tone varying in pitch and loudness according to the inductance, the capacity, the strength of the exciting current, and the length of the arc. The total or resultant current must be measured by electro-dynamometers or calorimetric ammeters, and the differences of potential by electrostatic or hot-wire voltmeters, because the electromotive force between the terminals of the arc is the resultant of a direct and an alternating electromotive force; and the square of this resultant is equal to the sums of the squares of the direct and of the effective alternating ($E_0/\sqrt{2}$). The Weston volt-meter and ammeter measure only the direct components. Now arrange things thus: Between two points C and C_1 there is an arc (branch III.): between C and C_1 there is a branch (branch II.) containing accumulators to feed the arc, and an inductance L in series with it; and again between C and C_1, a branch (branch I.) containing a capacity and an inductance L in series. In branches I., II., and III. are calorimetric ammeters; C and C_1 are joined by a calorimetric and a Weston volt-meter; the ends of the condenser are connected by an electrostatic and the end of the inductance L in branch I. by a hot-wire volt-meter. Increasing the inductance L, arc-length remaining the same, the alternating e.m.f. increases. The greater the inductance L, the smaller the needful current in branch II. The differences of potential between the extremities of the condenser and the extremities of the inductance L are, singularly, much greater than that between the points C and C_1, even though the hissing of the arc be extremely gentle. When the inductance is increased beyond a certain amount the arc fails unless the capacity is also increased. The sum of the last-mentioned two potential differences increases with increase of the inductance L. When the capacity is above 1 microfarad and the inductance is feeble, the arc begins to hiss. As the capacity is increased the exciting current in branch II. may remain the same; those in I. and III. increase; the difference of potential at the arc rises slightly, those at the extremities of the capacity and of the inductance L fall, and the sum of these last two differences tends to approach the difference between C and C_1; and the arc becomes gradually unstable. There is no direct current in branch I., and the direct current in branch III. (the arc) is slightly weaker than that in branch II. (the accumulators). When the exciting current is beyond a certain strength, the arc acts as if it were fed with a direct current only. To show the effects mentioned the arc must be from 0·75 to 1·00 mm.; and the effects are much affected by slight variations in the length of the arc; but there is a length for which they are a maximum under any given condition of the circuit. Branch I. has nothing but pulsations; a pulsating and a direct current (the latter sometimes much the smaller) travel along III. (the arc); and in II. the current is usually slightly pulsating. Putting a telephonic arrangement on a secondary coil of the inductance L, the telephone indicated an alternating current in branch I., and on reflecting light from the disc and photographing it, it was clear that the alternations were the summation of several components. With an extremely small inductance L (connecting wire merely), a capacity of 1 microfarad gives a frequency of 120,000 per second, which is inaudible; one of 20 microfarads gives a frequency of 7,000, and the arc audibly hisses. Increasing the inductance has the same effect of diminishing the frequency, which is almost inversely proportional to the capacity, but does not fall off as fast with increase of the inductance in circuit. If $L = 0·048$ henry and $C = 1$ microfarad, the frequency is 13,000; with 0·012 and 4, it is 8,500; with 0·003 and 16, it is 2,750; whereas if $1/n = T = 2\pi\sqrt{LC}$, n would have had the same value in all these cases; but increase of the capacity lowers the frequency more powerfully than diminution of the inductance raises it. The augmentation of apparent resistance under "skin effect" is far from explaining the anomalous differences of potential in branch I. But the equations,

Current strength—

$$I = \frac{E}{\sqrt{R^2 + \left(2\pi n L - \frac{1}{2\pi n C}\right)^2}} \cdot \sin\left\{2\pi n t - \tan^{-1}\left(\frac{2\pi n L - \frac{1}{2\pi n C}}{R}\right)\right\},$$

Condenser-voltage $V = -\frac{1}{C}\int I\,dt$, and inductance-voltage $V' = -L\,dI/dt$, lead to values of V and V′ which tend towards infinity as the limiting case $R = O$ and $(2\pi n)^2 LC = 1$ is being approached; but the two anomalously high potential-differences are opposed in phase, so that the conservation of energy is maintained. The greatest anomalous high tensions that have been observed are, however, only about four times the voltage between C and C_1; R is not $= O$, for it comprises the resistance of the arc, and the actual values of n fall short of the calculated values implied in the equations. With metals to form the arc, the arc ceases when the alternate-current branch, branch I., is closed; with iron —, carbon +, the same; with aluminium-carbon, the effects described appear for an instant and then the arc goes out; with silver-carbon the arc persists but the effects described do not appear; with steel-carbon the effects are very pronounced but transitory. When the metals are +, carbon —, the arc is not maintained; as if the development of the alternating e.m.f. depended on the mode of combustion in the arc. A. D.

1048. *Induction Coil Sparks and the Influence of the Primary Current on the same.* **F. Klingelfuss.** (Ann. d. Physik, 9. 5. pp. 1198–1216, Dec., 1902.

From the Verh. d. naturf. Gesell. in Basel, vol. 15.)—The sparks from a 100 cm. spark coil are photographed on a photographic plate which is mounted on the end of the shaft of a small motor. The author distinguishes three different kinds of spark, the brush discharge, the sharp blue spark, and the spark with "aureola." The connection between the primary current and the spark length is investigated for each kind of spark and plotted in curves, the spark in every case being that resulting from a single breaking of the primary circuit. Similar sparks are photographed with the plate stationary and also with the plate moving, and interesting plates are given in the paper showing the principal features of all the different kinds. The pulsating discharge in the case of the blue spark is extremely well shown. The photographs of the sparks with aureola show that the blue spark and the aureola are two different currents side by side differing in phase by an amount depending on the current, the greatest difference being 180°. The currents are pulsating, but unidirectional, and so result in a continuous discharge if their amplitudes are of equal magnitude and their phase difference 180°. The photographs enable the period of pulsation to be measured, and from this and the constants of the coil the secondary e.m.f. is calculated. A method is described for obtaining the number of turns in the secondary coil, when these are unknown, by means of a photograph of the spark. [See also Abstract No. 1941 (1901).] J. B. H.

1049. *Oscillatory Discharge through a Variable Inductance.* **E. W. Marchant.** (Phil. Mag. 5. pp. 155–161, Jan., 1903.)—When the discharge from a condenser passes through a coil with an iron core the phenomena are complicated by the variable inductance. A graphical method of dealing with such an inductance was originated by W. E. Sumpner, in 1887, for the sudden application of an e.m.f., and the present paper extends the method to the case of an oscillatory discharge. The fundamental equation—

$$\frac{d(\mathrm{L}i)}{dt} + \mathrm{R}i + \frac{\mathrm{Q}}{\mathrm{C}} = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

is transformed into—

$$\frac{di}{dt} = -\frac{i + \frac{\mathrm{Q}}{\mathrm{RC}}}{\mathrm{L}'/\mathrm{R}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where L' denotes $\mathrm{L} + i\,d\mathrm{L}/di$. Full instructions with diagrams then follow, showing how to plot the curve co-ordinating current (i) and time (t). It is noteworthy that as the potential difference dies away, the time of the half oscillation increases. Thus, in an example given, for potential differences of 9,400, 2,350, and 450, the respective times for the half oscillations are 2·9, 5, and 15·2, each multiplied by 10^{-5}. E. H. B.

1050. *Phosphorus Emanation.* **E. Bloch.** (Comptes Rendus, 135. pp. 1324–1326, Dec. 29, 1902.)—The author gives the results of some experiments he has carried out with the view of testing whether phosphorus emanation, which makes the surrounding air a conductor of electricity and has the property of condensing even unsaturated water vapour, gives rise to this conductivity by a true process of ionisation, or whether the conductivity is due to the convection of electricity by the products of oxidation of the phosphorus. Different observers have previously arrived at opposite views. When a steady current of absolutely dry air was passed over dry phosphorus at ordinary temperature, no sign was visible of the presence of any dust or smoke in the gas; but a cloud did appear where the air escaped from the apparatus and came in contact with the air outside. When the air is passed through the field of a cylindrical condenser, the current in the gas is not proportional to the e.m.f., but tends towards a maximum when the e.m.f. is sufficiently high. Further, the conductivity in the gas can be completely destroyed by sending the gas through an electrostatic field with sufficiently high e.m.f. These phenomena justify the hypothesis of an ionisation of the gas, and the author considers the conductivity due to ions of very small velocities, which act as nuclei for the condensation of water vapour. The chemical mechanism by which the ions are produced, and the question whether their formation is bound up with that of a definite compound, such as ozone or an oxide of phosphorus, or results from a simple modification of oxygen, are problems which still remain for settlement. W. C. H.

1051. *Production of Kathode Rays by Ultraviolet Rays.* **M. Lamotte.** (Journ. de Physique, 1. pp. 778–784, Dec., 1902.)—The author sums up the experiments carried out by Lenard [see Abstract No. 97 (1901)], J. J. Thomson, and Merritt and Stewart [see Abstract No. 103 (1901)] upon the loss of the charge provoked in a negatively charged conductor when ultraviolet rays fall upon it—a phenomenon first observed by Hertz. There appears to exist a force antagonistic to the loss in the neighbourhood of the surface. A negatively charged body retains its charge in a vacuum in spite of the action of its own field. This force is exerted only up to a very small distance from the surface. The simplest origin which can be attributed to this antagonistic force is to suppose that it arises from the action exerted between the charges escaped from the surface and their electric images in that surface. Experiments carried out in very high vacua, in partial vacua, in gases under considerable pressure, and in gases at ordinary pressures are referred to. From the behaviour observed in these various experiments the peculiar constitution of the molecules and atoms may be inferred. The space occupied by the molecule or by the atom is impenetrable by its companions, but in the interior the molecule or atom is made up of finer particles which are separated by numerous empty spaces and which possess great freedom of movement. In gases at ordinary pressure, the photo-electric phenomenon is very feeble; the rays appear to be rapidly absorbed by the gas. A double layer is formed at the surface of the electrode, and the action of this double layer provokes the return to the electrode of the lost charges. It is only under a pressure sufficiently reduced that the phenomenon is able to manifest itself, at a certain distance from the surface, when the mean free path of the particles has acquired a certain magnitude. J. J. S.

1052. *Light and Electric Radiation.* **J. C. Bose.** (Roy. Soc., Proc. 70. pp. 154–174, June, 1902.)—The researches described in previous papers [see Abstracts Nos. 2452 and 2453 (1900)] led the author to believe that radiation gives rise to molecular strain. In the present paper the author describes a large number of experiments tending to confirm this conclusion, and showing that light waves and electric waves of longer period produce similar conductivity and e.m.f. variations. The curves obtained are of the same character—they both exhibit reversals, with a tendency to a limit under the action of continued radiation. The recording apparatus employed, which is fully described, consisted of a modified railway myograph. G. W. de T.

1053. *Radiation and Mechanical Strain.* **J. C. Bose.** (Roy. Soc., Proc. 70. pp. 174–185, June, 1092.)—In this paper the author describes experiments in which the effects produced by torsion and other mechanical strains are compared with those due to radiation. The conclusions arrived at are that in whichever way the molecular effect is produced : (1) It may be detected either by conductivity or electromotive variation methods. (2) Substances not overstrained exhibit rapid recovery, the time of recovery increasing as the overstrain increases. (3) Response is modified by previous history and surrounding conditions, slight rise of temperature and annealing being each usually favourable to sensitiveness and quick recovery. (4) Both increase and decrease of resistance, and positive and negative e.m.f. variations are observed. (5) The curves are exactly similar in character, the ascending portions being abrupt, while the fall during recovery is at first rapid, and then comparatively slow. (6) Under a rapid succession of stimuli the individual effects are fused together : the curve rises to a maximum when the force of restitution is kept balanced by the distorting force. (7) A very small stimulus often produces a reverse effect, and long-continued disturbance tends to cause a reversal. (8) A reverse effect may arise from peculiar molecular modification, in which case the normal effect can be obtained by continued stimulation. As the author found that electric radiation increases the conductivity of tin, while mechanical vibration decreases it, he tried to balance one against the other in producing electromotive variation. He succeeded perfectly in this, and when the balance was obtained it could be upset by an increase or diminution of either disturbance. G. W. DE T.

1054. *Electric Waves in Mechanically Disturbed Metal in Contact with Electrolyte.* **J. C. Bose.** (Roy. Soc., Proc. 70. pp. 273–294, July 29, 1902.)—If two points A and B on a metal rod are connected, through non-polarisable electrodes, with a galvanometer, and a point O of the rod is struck, a wave of molecular disturbance will reach A and B. The author shows that this is accompanied by an electric wave. The electric changes at A and B will continuously balance each other, and the resultant effect on the galvanometer will be zero, (1) when the mechanical disturbance reaches A and B simultaneously and with the same intensity, (2) when the molecular condition is similar at the two points, and (3) when the rate of rise and subsidence of disturbance is the same at the two points. A disturbance may be made to reach A and not B by blocking the path by means of a clamp at some point which lies between O and B, but not between O and A. This the author terms the method of block. Again, a resultant differential action may be obtained by relatively exalting or depressing the electrical excitability of one point with regard to the other by physical or chemical means. The conclusions are summarised as follows : 1. Molecular disturbance produced by mechanical stimulus gives rise to an electrical disturbance. In the majority of cases under normal conditions the responsive electrical current in a wire is from the less to the more disturbed. 2. Response may be obtained by (1) the method of block, (2) methods of negative or positive variation. 3. The electromotive variation disappears on the cessation of disturbance. 4. The intensity of the electrical variation produced by a given disturbance is modified by the molecular condition of the wire. Annealing, or previous continued vibration, enhances the electric effect. 5. The abnormal response due to molecular modification is transformed into normal by continued vibration. 6. The intensity of electromotive variation is increased with increasing intensity of stimulation. 7. In a curve—the ordinates representing the electrical effects, and the abscissæ the amplitudes of vibration—the first part is slightly convex to the abscissa, the second is approximately straight, and the third concave. With increasing stimulation there is a tendency for the electrical variation to reach a limit. 8. A maximum electrical effect is produced by continuous vibration, which is definite for a given amplitude of vibration. A curve showing the relation between the maximum effect and the amplitude of vibration exhibits the same characteristics as in the last case. 9. Hysteresis is exhibited in cycle curves. The forward and return curves tend to coincide after several cycles. Previous annealing reduces hysteresis, and after one or two cycles the wire assumes a constant condition of sensibility. 10. Chemical reagents may profoundly modify the electric excitability. The after-effects are sometimes very persistent. 11. The effect of weak solution is sometimes the opposite to that of strong solution. 12. By touching different points of the wire with different reagents the excitabilities of these portions are rendered unequal. Hence a resultant electromotive variation may be obtained by vibrating the wire as a whole. The current in the wire is from the less to the more excitable. 13. By this method invisible traces of physico-chemical change in a wire may be detected. 14. Chemical reagents not only change the excitability but the quickness of response. Two points having two different rates of excitation will thus, under proper conditions, give rise to diphasic effects. G. W. DE T.

1055. *Potential along a Wire Transmitting Electric Waves.* **C. A. Chant.** (Amer. Journ. Sci. 15. pp. 54–68, Jan., 1903.)—Electric waves, generated by oscillators of four different types, were passed along a single wire, and the potential along it explored by means of a Rutherford magnetic detector. With the smaller oscillators, the positions of the minima found for any particular length of wire were independent of the size of the oscillator, but depended only on the wire's length. With the larger oscillators the positions of the minima were found to depend only on the size of the oscillator and not at all on the length of the wire. It is hoped to apply the same methods to much longer wires shortly. E. H. B.

1056. *Hertz Oscillator.* **R. Swyngedauw.** (Journ. de Physique, 2. pp. 14–36, Jan., 1903. Communication made to the Société Française de Physique, April 5, 1902.)—The half period T of an Hertzian oscillator is given by—

$$\frac{\pi}{T} = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}},$$

where L, C, and R denote respectively the inductance, capacity and resistance involved. It thus follows that a change in R produces a slight change in T. Now that part of R due to the spark-gap is first diminished and then increased by the heating and subsequent cooling occurring there. Hence the period should at first decrease and afterwards increase. This theoretical result has been experimentally confirmed by a special arrangement. It is found that the successive half periods decrease to the second or third and then regularly increase to the end of the discharge. E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1057. *Conductivities and Relative Densities of Sea Water.* **J. J. Manley.** (Roy. Soc. Edinburgh, Proc. 24. pp. 347–362, 1902–1903.)—The author describes fully the apparatus used and the precautions taken in measuring the electric conductivities of various samples of sea water taken from different places at various temperatures and at various densities. The different densities from a given sample were obtained by concentrating by evaporation, and by adding distilled water. He fails to find any simple relationship between the conductivity and the relative density. The variation of resistance with temperature is not found to follow the straight line law, but involves two temperature coefficients, and these differ with the relative densities. An attempt to discover some definite and simple relationship between the electric conductivity and the amount of chlorine contained in the water met with no greater success. E. C. R.

1058. *Electric Wave Detector.* **G. M. Minchin.** (Elect. Rev. 51. p. 770, Nov. 7, 1902. Paper read before the British Association at Belfast.)—The receiver consists of a small cylinder of carbon whose ends are supported in two loops of aluminium wire. An aluminium wire, about $\frac{1}{16}$ in. in diameter, *m* A B *n*, (Fig. 1), is bent into the shape represented in Fig. 1, there being two small loops at *m* and *n* into which the ends of a small carbon rod fit horizontally; the length A B is about 1 cm. or less. The carbon cylinder, C, has a fine platinum wire *q*, attached to it, and the aluminium wire A B has a platinum wire, *p*, attached. The system is put inside a small glass tube, G, the lower end of which contains some mercury into which the wire *q* dips, this mercury being also in contact with a platinum wire, Q, sealed into this end of the tube. The wire *p* is sealed into the upper part of the tube, and led out as a terminal P for connection with the enclosed aluminium wire A B. Before the tube is sealed at its upper end the mercury is boiled, so that the tube is filled with mercury vapour, and in this condition it is sealed. The contacts of the carbon cylinder with the aluminium loops at *m* and *n* are the places where the electrical resistance of the circuit P *p* C *q* Q is affected by electric oscillations. The apparatus for receiving the waves sent out by a distant oscillator consists of a large metal plate, P (Fig. 2), mounted on the top of a pole. P is earthed at E through a coil, L, of large inductance, but small resistance, a single dry cell C, the above described coherer G, and a telephone T, being arranged in a side circuit, as represented in the Figure. The arrangement is remarkably sensitive, the telephone indicating every dot and dash sent by the oscillator. When the telephone was replaced by a relay, for recording, it was found that the coherer G did not sufficiently decohere, without tapping, to work the relay. The amount of decoherence is, however, quite sufficient to affect the telephone without any tapping. G. W. de T.

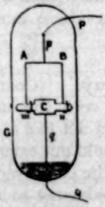


Fig. 1

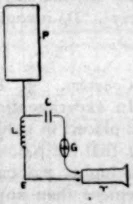


Fig. 2.

1059. *Wehnelt Interrupter.* **D. A. Goldhammer.** (Ann. d. Physik, 9. 5. pp. 1070–1082, Dec., 1902.)—When a Wehnelt interrupter is connected in a circuit of self-induction L, the potential difference between the electrodes being E, the current *i* is generally regarded as passing through zero when $t = 0$; it is supposed to be a maximum at a time τ, and to fall again to zero after an interval θ. That is to say, the period is represented by $T = \tau + \theta$. Simon found an expression for τ as a function of E and L. Klupathy has recently shown that the Peltier effect must be taken into consideration, thus introducing a further term into the expression for *i*. The author fully discusses this new condition. In the absence of experimental proof his results must, however, be regarded as merely theoretical and inconclusive. [See also Abstracts Nos. 1520 (1899) and 571 (1903).] R. A.

1060. *Magnetic Electric Wave Detector.* **G. Marconi.** (Roy. Soc., Proc. 70. pp. 341–344, July 29, 1902.)—The author describes a form of Rutherford's magnetic detector of electric waves [Roy. Soc., Phil. Trans. (1897)], which he has successfully employed over distances extending up to 152 miles. He obtains the best results with cores formed of hard-drawn iron wires which have been stretched or twisted beyond the limits of elasticity. Good results are obtained with an endless core revolved between the poles of a horse-shoe magnet. G. W. DE T.

1061. *The Italian Navy Coherer.* (Electrician, 49. pp. 387–388, June 27, 1902.)—The article illustrates the coherer employed in the Italian navy experiments by Bonomo, Castelli, and others [and which is essentially Tommasina's mercury coherer]. Its invention is here ascribed to Castelli. G. W. DE T.

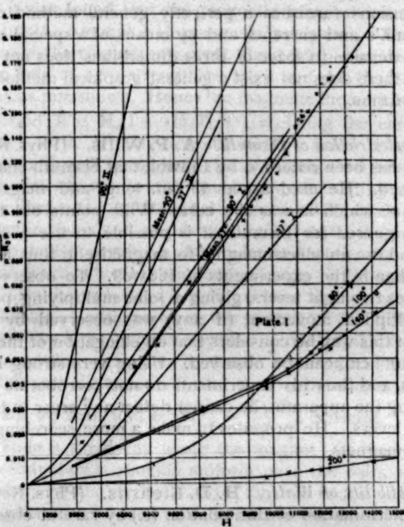
1062. *Steel Needle Coherers.* **J. Fényi.** (Comptes Rendus, 135. pp. 30–32, July 7, 1902.)—In experimenting with the steel needle coherer, the author finds that several placed in parallel act like a single one, and require, for satisfactory working, that the p.d. should not exceed 0·25 volt. He finds, however, that circuits of higher p.d. can be employed by connecting several in series. The arrangement then approximates to the filings coherer, but with the advantage, especially for measurement purposes, that the number of contacts is a definite fixed number. G. W. DE T.

1063. *Action of Filings Coherer.* **M. A. Ketterer.** (Journ. de Physique, 1. pp. 589-594, Sept., 1902.)—The author describes a number of experiments made upon filings coherers with nickel and other electrodes. The results show that: (1) The application for short periods of steady e.m.f.'s of varying amount produces a decrease of resistance which increases with the e.m.f., and the decrease for a given e.m.f. is less with ascending than with descending e.m.f.'s. (2) The effect of spark discharges varies greatly for coherer electrodes of different materials. (3) When the current and self-induction in the spark circuit are both varied, the greatest drop is observed with a self-induction which is greater the smaller the current, and conversely, with a current which is smaller the greater the self-induction. G. W. DE T.

1064. *Relay Telephone Receiver for Wireless Telegraphy.* **A. H. Taylor.** (Phys. Rev. 15. pp. 39–43, July, 1902.)—The author obtained satisfactory transmission over a distance of about a mile with laboratory apparatus. The receiver consisted of a box relay of 179 ohms resistance, with nickel contacts in its secondary, which contained also a telephone receiver of 100 ohms resistance and a dry cell. The apparent resistance of the contact varied from 350 to 30 ohms. A condenser was placed across the primary terminals of the relay, making the signals sharper by counteracting the e.m.f. of self-induction of the relay, which would otherwise, for fine adjustments, itself cause coherence of the secondary. G. W. DE T.

ALTERNATING CURRENTS AND MAGNETISM.

1065. *Temperature Change of Resistance of Bismuth in a Magnetic Field.* **F. B. Jewett.** (Phys. Rev. 16. pp. 51–59, Jan., 1903.)—The author employed bismuth spirals formed by casting in shallow slightly trapezoidal grooves in iron plates, the wires thus formed were filed down to the desired cross-section, and then recrystallised by placing on a metal plate heated to slightly above the melting-point of bismuth, the surface tension at the same time caused the cross-section of the wire to become round. The wire can then be bent into any desired shape by working it on the hot plate. The spiral is kept at any desired temperature by immersing it in a bath of heavy mineral oil, contained in a brass box with insets at the sides to permit of the close adjustment of the pole pieces. The heating is accomplished by means of a Bunsen burner, and a fairly constant and even temperature maintained by means of an electrically driven propeller. The paper is illustrated with curves and tables giving results from temperatures of —90° C. up to 241° C. in magnetic fields up to 15,000 c.g.s. units. From examination of the plotted curves (abscissæ values of H, ordinates values of $(R - R_0)/R_0$, where R_0 is the resistance at any temperature in zero field, and R the resistance at the same temperature in field H), they seem to consist of two straight lines representing regions of uniform variation, connected by a more or less extended curve denoting a region of non-uniform variation; in each case



$(R - R_0)/R_0$ is greater in the second half of the curve. As the temperature is raised this variable portion seems to travel towards the region of denser magnetic flux. Even more striking is the apparent existence of fairly well defined temperatures of subsidiary minimum and maximum variation in the region below $H = 10{,}000$. The author finds that in thin plates of non-crystalline bismuth, formed by means of a kathode stream, no evidence of any magnetic effect on the resistance is observable, even at a field strength as high as 27,000. E. C. R.

1066. *Graphical Treatment of Alternating Current Problems.* **E. Orlich.** (Elektrotechn. Zeitschr. 24. pp. 59–60, Jan. 22, 1903.)—The author considers the question as to how far the ordinary vector method of representing alternating currents is applicable to irregular wave-forms. He shows that the phase e.m.f.'s of a star-connected three-phaser cannot in general be correctly represented by three co-planar vectors, but that they may be represented by the three edges of a pyramid. He then considers if such a system of vectors in three dimensions furnishes a perfectly general method of representing alternating e.m.f.'s and currents, and by means of a special example shows that even the extension to space of three dimensions does not meet the difficulty, and that there does not exist a general graphical method applicable to irregular wave-forms. A. H.

1067. *Magnetostriction of Bismuth.* **A. P. Wills.** (Phys. Rev. 15. pp. 1–6, July, 1902.)—It has been recorded by Bidwell that bismuth changes in length when magnetised. He used a rod 13 cm. long, and magnetised it by a solenoidal coil, of which it was the core. Wills points out that, since end effects can be ignored for bismuth, it is possible to use a short specimen (1 cm. long), and use an electromagnet to magnetise it, thus attaining a field much greater than in the experiments of Bidwell. To observe any changes in length he uses two light levers, giving a joint multiplying power of about 650. The multiplied movement (if any) was observed by a micrometer microscope. In this way he considers that an elongation of the bismuth of as little as $1{\cdot}3 \times 10^{-8}$ cm. can be observed. Using very strong fields, he finds negative results, and thus his experiments do not corroborate those of Bidwell. On testing the apparatus, he cannot detect any error in the mechanical working of the levers. He proposes to make a more searching test by using more powerful magnets. P. E. S.

1068. *Susceptibility of Water.* **H. D. Stearns.** (Phys. Rev. 16. pp. 1–10, Jan., 1903.)—Determination of this relation (K) by careful observers vary by 25 per cent.; the temperatures of the determination have also ranged from 10° to 20°; but since the temperature coefficient of K is only 0·002, it is evident that the values differ greatly even when reduced to one standard temperature.

The author makes a redetermination. His method is to place a right cylinder of water supported vertical on the pan of a balance, using a strong field H at the bottom end of the cylinder, and acting perpendicular to its axis, and having no field acting at the upper end. If q be the cross-section of the cylinder, and p the magnetic repulsion in grams on the cylinder, $K = -2pg/H^2q$. The glass tube containing the water is sealed abruptly, and placed in the centre of the air space between the parallel pole-pieces of a large electromagnet. For determining the value of H, test coils are used either to be rotated through 180° in the field, or suddenly drawn away from it; their induction currents are compared with those from an earth inductor. The value of H varies from 7,500 to 10,000. The greatest care is taken to measure the factors accurately, and the author places the extreme possible error at 2·5 per cent. The results agree most closely with those of Henrichsen. K comes out for 22° to be $-0{\cdot}733 \times 10^{-6}$. P. E. S.

1069. *New Magnetometer Experiments.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 12. pp. 27–33, Jan. 23, 1903.)—Two new forms of magnet are described. I. *A vibration magnetometer.*—A rod of steel 10 diameters long, and a long aluminium index, are thrust through a brass cylinder about fifty times as heavy as the magnet. All is made rigid and suspended by a fibre from a simple torsion head, the brass cylinder thus rotating on its axis while the rod and index are perpendicular to it at its base. The magnet should have its centre accurately in the axis of the cylinder, and it will then be found that the system vibrates steadily *without pendulous motion* even in an ununiform field. By placing the magnet in a coil through which a current could be varied it was found that the magnetic moment increased proportional to field by the amount 1·11 per cent. per gauss. Thus the earth's field (0·18) increases the magnetic moment about 0·2 per cent. If the magnetic moment in field of zero strength be M_0, in a field H it is $M_0(1+\lambda H)$, where $\lambda = 0{\cdot}0111$ as just shown. Hence the magnetic moment in a field giving the vibration period T is $M_0(1+\lambda H_E T_E^2/T^2)$, H_E being the earth's field and T_E the period due to it. Finally to compare two fields, H_1 and H_2, by the periods of vibration T_1 and T_2, we have $(H_1 + fH_E/H_2 + fH_E) = T_2^2/T_1^2$, where f is a constant, determined in the usual way, depending on the torsion coefficient of the fibre. II. *A ball-ended magnet.*—Balls of steel or soft iron have holes drilled in them, and are driven tightly on to the ends of a thin steel rod. These balls provide an easy inlet and outlet for the magnetic induction, so that practically all the induction enters by them, none entering by the rods. If also the induction is uniform over them, the magnet would act like an ideal magnet with poles at the centre of the balls. Two tests were applied. (1) Place the magnet vertical in one of the Gauss positions near the magnetometer, note the distance r and deflection θ, and repeat observation at different distances. If the centres of magnetism are at the centres of the balls we shall find $\tan\theta\left(\frac{1}{r_1^2}-\frac{1}{r_2^2}\right)^{-1}$ a constant. This is found to be true. (2) Slide a small coil along the magnet; in this way it can be shown that the induction is roughly uniform over the balls, and that nine-tenths of it enters by the balls. Lastly, the ball-ended magnet and the special magnetometer can be used to demonstrate the law of inverse square by vibration; for it is evident that we know exactly in any experiment the distance between each magnet pole and the centre of the magnetometer needle. P. E. S.

1070. *Effect of Temperature on Hysteresis Loss in Iron.* **R. L. Wills.** (Phil. Mag. 5. pp. 117–133, Jan., 1903.)—The method employed is due to G. F. C. Searle (Proc. Camb. Soc. vol. ix. pp. 2–6, 1895). The movable coil in an electrodynamometer is in series with the secondary coil round the specimen, while the fixed coil is in series with the magnetising coil. The theory has been given previously by Searle and Bedford [see Abstract No. 886 (1902)]. Temperatures vary from 15° to 770° C., and induction rises to 10,000. It is shown that the hysteresis loss of energy falls at 750° to 15 per cent. of the amount at 15°, induction being 10,000. As the critical temperature 776° is approached, the hysteresis loss diminishes at a smaller rate. This is more noticeable in an alloy containing 4·5 per cent. tungsten. Special experiments are made on the "ageing" of iron. A specimen is kept heated at 165° using a constant induction 5,000; the hysteresis loss is found to increase rapidly at first, reach a maximum in four days, and then decrease slightly to a constant value. P. E. S.

1071. *Resistance of Magnetised Nickel at different Temperatures.* **C. G. Knott.** (Roy. Soc. Edinburgh, Trans. 40. 3. pp. 535–545, Dec. 31, 1902.)—Two identical nickel wires are wound into two similar flat coils to serve as anchor-ring cores for magnetising coils to be wound on; each magnetising coil is made in two parts, so that when current is opposed there is no magnetisation, but when the two parts carry like currents we have magnetisation; thus by reversal in one coil we can pass from strong magnetising force to none, and yet keep the heating effect of the coil constant. The nickel wires formed neighbouring arms in a Wheatstone bridge and the same current passes in them, but generally only one was magnetised at once. The coils were placed in heating baths to acquire any required temperature. The problem is to discover what influence temperature has on the change in resistance which magnetisation is known to produce in the nickel. Three standard temperatures were used—12°, 57°, 93°. The field varied from 0 to 70 c.g.s. The changes in resistance as field and temperature varied were calculated from the known theory of the bridge. It is found that the change in resistance is an increase while temperature is constant and field increases, while it is also an increase when field is constant and temperature increases. The greatest increase observed is for the highest field used. It is then $\frac{1}{3}$ ohm in 1,000 ohms for 80° rise in temperature. The curves show a hysteresis looping. The author touches upon the bearing which the results have on the corpuscular theory of electric conduction. P. E. S.

1072. *Determining the Variation in Magnetic Inclination.* **H. Wild.** (Acad. Sci. St. Pétersbourg, Bull. 13. pp. 509–515, Dec., 1900.)—Having demonstrated, some years previously, that of the various apparatus for determining the variation in the vertical intensity, only Lloyd's balance (with temperature compensation) could be relied upon, the author, in conjunction with M. Th. Edelmann, has been attempting to design a more delicate instrument, based upon the currents induced by the earth's magnetism in a conductor kept in uniform motion. As in the induction inclinatorium of L. Weber, two equal coils are applied, rotating at the same rate about a vertical and a horizontal axis respectively, and joined to galvanometer coils. The author discusses the theory of the instrument and describes experiments. A final type had not yet been constructed. H. B.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1073. *Electric Response in Plants under Mechanical Stimulus.* **J. C. Bose.** (Extract from Linnean Soc., Journ. 35. pp. 275–304, 1902.)—In this paper the author describes an extension to vegetable substances of the researches dealt with in Abstract No. 104 (1901). The methods of investigation were similar to those employed in the earlier paper and others already dealt with [see Abstract No. 1054 (1903)]. It is shown that the electric response is a faithful index of physiological action. The results obtained agree closely with those previously observed in the case of animal tissues and metals. The absence of electric response is the most certain and delicate indication of death in a plant. G. W. DE T.

1074. *Electric Properties of Muscles and Nerves.* **S. Tchirieff.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 317–329, Oct., 1901.)—The author shows that absolutely insulating muscles and also nerves do not give any definite potential differences. If such an inactive electrical muscular string is excited it will not lead any excitation current from the point of excitation, and still less any action current according to Hermann's views, whereas in both directions a peculiar process, resulting in the muscle being contracted, takes place. These phenomena, it is pointed out, have been incorrectly accounted for by Du Bois Reymond on the latter's molecular hypothesis of par-electronomy. A. G.

1075. *Muscle Curves with Superposed Currents.* **Bordier** and **Schickele.** (Archives d'Él. Médicale, 10. pp. 689–691, Nov., 1902.)—When the continuous and interrupted currents were equal, and in the same direction, the curve rose rapidly to the tetanisation point. Increase of the former causes the curve to rise almost vertically, falling more gradually to tetanisation. When the latter current predominates, the curve rises as before, falls slightly, and again rises to a still higher level, which is maintained. When the currents are opposed and equal, no contraction occurs. H. W. P. Y.

1076. *Effects of Electrical Stimulation of the Small Intestine.* **Laquerrière** and **Delherm.** (Archives d'Él. Médicale, 10. pp. 711–714, Nov., 1902.)—Attention is called to the fact that numerous physiologists have worked at this subject, but their results have not been identical. When the intestine is stimulated by a constant current, contractions are obtained, differing in character at the two poles. A current of 1 milliampere or less is sufficient to produce the positive pole contraction, which attains its maximum in a few seconds and is unaffected by the position of the electrode. It lasts while the currrent lasts, disappearing rapidly after it has ceased. At the negative pole the contraction is difficult to obtain, appears later, developes slower. When the current is weak, contraction is limited to near the electrode; with strong currents the stricture becomes circumferential. The contractility increases as the electrode is moved from the free to the mesenteric border. With currents of brief duration, the contraction may continue to develop after they have ceased. The longitudinal fibres are not excited by a continuous current. Interrupted currents produce a circumferential stricture, which tends to spread and is maintained throughout the application of the current. If the electrodes are placed on the intestine at some distance apart, there are peristaltic movements; these currents therefore invoke contraction of the longitudinal muscle fibres. H. W. P. Y.

REFERENCES.

1077. *Electric Waves and Marconi's Telegraphy.* **G. Seibt.** (Elektrotechn. Zeitschr. 23. pp. 315–319, April 10; 341–344, April 17; 365–369, April 24; 386–388, May 1, and pp. 409–412, May 8, 1902.)—A series of mathematical papers giving a very full treatment of the theory of electric "wire waves" with reference to Marconi's telegraphy. E. H. B.

1078. *Electromagnetic Theory of Dispersion in Isotropic Non-conductors.* **M. Planck.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 24. pp. 470–494, May 1, 1902.)—A review of the development of the various theories of dispersion shows, among other things, a want of agreement in respect to the physical significance of the constants introduced. The consequences are deduced which follow on assuming that the damping of the molecular vibrations set up by selective absorption is caused by radiation of energy. G. E. A.

1079. *An Electromagnetic Theory of Weight.* **H. A. Lorentz.** (Archives Néerlandaises, 7. pp. 325–342, 1902. From the Zittingsversl. Kon. Akad., March 31, 1900.)—This is a French translation of the notable paper in which the author demonstrated the possibility of an electromagnetic theory of gravitation which should agree with the law of Newton, as far as bodies at rest are concerned, and which should not require a rate of propagation of gravitational attraction exceeding that of light. G. W. DE T.

1080. *Energy Waste from Moving Electrons.* **O. Heaviside.** (Nature, 67. pp. 6–8, Nov. 6, 1902.)—The author here indicates several methods of mathematically attacking the problem of determining the waste of energy occurring in moving electrons. G. W. DE T.

1081. *Atmospheric Electricity and Lightning Protectors.* (Engineering, 73. pp. 703–707, May 30; 767–769, June 13, and pp. 802–803, June 20, 1902.)—This is a useful summary, with references to a large number of original papers.

1082. *Lecture Illustrations of Electric Waves and Resonance.* **G. Seibt.** (Elektrotechn. Zeitschr. 24. pp. 105–108, Feb. 5, 1903. Report read before the Elektrotechnischen Vereins, Nov. 25, 1902. Also Phys. Zeitschr. 4. pp. 99–104, Oct. 15, 1902.)—Accounts are given of striking lecture experiments (1) rendering visible electric waves by the luminescence of the space between wires on which stationary waves are formed, (2) illustrating "tuning" in wireless telegraphy, (3) showing acoustic-electric analogues. E. H. B.

1083. *Resonance in Wireless Telegraphy.* **M. Wien.** (Ann. d. Physik, 8. 3. pp. 686–713, June, 1902.)—This is a theoretical paper applying to the problems of wireless telegraphy the mathematics familiar to physicists when treating forced vibrations in the domain of acoustics. Resonance, the sharpness of resonance, the effect of more or less damping in the receiver, and other matters are dealt with and illustrated by diagrams and numerical examples. E. H. B.

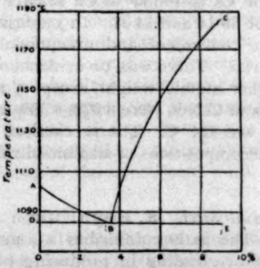
1084. *Resistivity and Temperature.* **Ponsot.** (Comptes Rendus, 136. pp. 87–89, Jan. 12, 1903.)—A theoretical paper, mostly analytical, upon the relations between resistivity and temperature. The conclusions arrived at are (1) that resistivity is nothing at absolute zero, (2) that the relation between resistivity and absolute temperature is unknown. J. W. P.

1085. *Capacity of Cables.* **H. Kath.** (Elektrotechn. Zeitschr. 24. pp. 38–40, Jan. 15, 1903.)—The author deals with the problem of the effect of capacity in relation to resonance, somewhat on the same lines as Breisig [see Abstracts Nos. 1172 (1899), 918 (1903), and Leblanc [Trans. American Inst. Elect. Eng. p. 525, vol. 19 (1902)]. R. A.

1086. *Wattless Currents.* **C. P. Feldmann.** (Schweizerische Blätter für Elektrotechnik, 8. pp. 3–5, Jan. 8, and pp. 11–14, Jan. 22, 1903. Paper read before the Elektrotechnische Gesellschaft at Cologne.)—The paper contains a general discussion of the effects of wattless currents. A. H.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1087. *Researches on Steel and Copper. Reports from the Royal Mechanical and Technical Testing Institute of Charlottenburg.* **E. Heyn.** (Metallographist, 6. pp. 39–64, Jan., 1903. Paper read before the International Association for Testing Materials, Budapest Congress, 1901.)—(1) *Iron and Hydrogen.*—Mild steel heated in an atmosphere of hydrogen at 730° to 1,000° C. and then quenched in water becomes remarkably brittle, though its density and structure are perfectly normal, and the weight of hydrogen occluded does not exceed 0·0002 per cent. The effect slowly penetrates from the surface inwards, and can be completely removed by heating in air or nitrogen, and even by heating in an atmosphere of hydrogen below 730° or by prolonged exposure to air at ordinary temperatures. It is pointed out that 0·028 per cent. of hydrogen in electrolytic iron renders it as hard as glass, and the brittleness observed by Ledebur in corroded steel was produced by only 0·002 per cent. of hydrogen. (2) *Copper and Hydrogen.*—Copper heated in hydrogen above 600° becomes excessively brittle, its density falls from 8·9 to 8·4, and its microscopic texture is also changed; this may be partly due to reduction of cuprous oxide, but the hydrogen probably produces a specific effect on the metal. (3) *Copper and Oxygen.*—Copper and cuprous oxide are completely miscible when fused, but are mutually insoluble in the solid state. The eutectic-point lies about 20° below the melting-point of copper, and corresponds with the presence of 3·4 per cent. Cu_2O; alloys with less oxygen contain copper crystals surrounded by eutectic, those containing more oxygen contain dendritic crystals of cuprous oxide surrounded by eutectic. The curve of freezing-points is shown in the figure. (4) *Permanent Deformations at Ordinary Temperatures.*—In a piece of the softest basic Martin steel 10 mm. thick and bent over a dome of 10 mm., the average dimensions of the crystal particles in two directions when magnified 365 diameters were :—



Percentage of Cu_2O.

Stretched side, bent cold	6·6 mm.	13·5 mm.
Centre „ „	11·1 „	11·9 „
Compressed side „	12·6 „	8·3 „
Stretched „ bent at blue heat	11·3 „	11·4 „

Thus whilst bending at a high temperature leaves the particles equally developed; cold working produces a very marked distortion in the shape of the actual crystal-particles of which the metal is composed. The following table shows how the distortion of the particles, measured in three directions, produced in a piece of cold-worked copper gradually disappears on annealing:—

	Copper rich in Oxide.	Copper poor in Oxide.
Cold worked	26·4 : 28·5 : 46	27·4 : 35 : 46
Annealed at 480° C.	26 : 26 : 27	26 : 29 : 35
„ 660° C.	33 : 33 : 32	26·5 : 27 : 25

A higher temperature is necessary for annealing the copper poor in oxide. [See also Abstract No. 769 (1903).] T. M. L.

1088. *Revision of the Atomic Weight of Cæsium.* **T. W. Richards** and **E. H. Archibald.** (Amer. Acad., Proc. 38. No. 16. pp. 443–470, Jan., 1903.)—As an outcome of 42 analyses, involving seven different ratios and three compounds of cæsium—the chloride, the bromide, and the nitrate (the latter a decomposition with silica first worked out by the authors for this purpose),—the atomic weight of Cs is found to be 132·879 [0 = 16]. Incidentally K and N are found to be 39·14 and 14·04. In confirmation of Wells, cæsium dichloriodide affords a convenient and exceptionally thorough means of purifying cæsium material. There was no evidence of the presence of any similar element of higher atomic weight, except a trace of thallium. The sp. grs. of CsCl, CsBr, and $CsNO_3$ were 3·972, 4·380, and 3·687, and the melting-point of the nitrate was 414° C. The precautions necessary to effect the precisely quantitative decompositions of alkaline nitrates are described.

S. R.

1089. *Overheating Mild Steel.* **E. Heyn.** (Iron and Steel Inst., Journ. pp. 3–39, Sept., 1902.)—The author describes a number of experiments to determine the effect of overheating in producing brittleness in mild steel. He finds brittleness produced in low-carbon mild steel by long continued annealing at temperatures exceeding 1,000° C. Prolonged annealing for a fortnight or so at 700° to 890° reduces brittleness to a minimum value, although leading to the formation of coarse ferrite grains. The brittleness can also be eliminated by half an hour's annealing at somewhat over 900°, but between this and 1,100° there is a limit beyond which brittleness increases with time, the more rapidly the more this limit is exceeded. Below 800°, five hours' annealing is insufficient to eliminate brittleness. Forging or rolling eliminates brittleness due to long-continued exposure to high temperature. The fracture, when overheated, is usually, but not invariably, coarse grained.

G. W. DE T.

1090. *Effect of Reheating on Overheated Steel.* **K. F. Goransson.** (Metallographist, 5. pp. 216–228, July, 1902.)—It is known that steel which has become coarse through over-heating can be made fine by reheating to a certain temperature. The author describes experiments leading to the conclusions that the destruction of the coarse net-work of cementite is caused by solution of its carbon in the martensite, and that the net-work surrounding the new grains is formed by the expulsion of cementite from the martensite as it is being cooled. According to this theory, the steel should be heated to a sufficiently high temperature to ensure complete solution of the cementite. Some comments by **H. M. Howe** are given as an appendix to the paper.

G. W. DE T.

1091. *Unusual Crystals of Cast Iron.* **J. E. Johnson, Jr.** (Metallographist, 6. pp. 14–19, Jan., 1903.)—Very large crystals were obtained having the composition C (graphite) 6·08, C (combined) 0·60, Si 0·47, S 0·220, Mn 0·89, P 0·83, many of them measuring an inch across. They were found in the outer edge of the hearth of a blast furnace which had been running for about three years, and had been formed in the layer of material intermediate between the original fire-brick of the hearth and the molten iron above it, a layer which with regular furnace work remains for months in a practically constant condition just below the melting-point. The carbon is nearly double, and the sulphur more than seven times as great as in the iron produced by the furnace, and must have been gradually accumulated from the coke under specially favourable conditions, the specimen being protected by the supernatant liquid iron from the desulphurising action of the slag and the oxidising action of the air. A similar accumulation of sulphur was observed in the iron plates built into the top of the furnace lining which had been partially melted whilst blowing out the furnace, leaving magnificent silvery crystals almost entirely free from graphite, and containing S 0·124, P 0·80, Si 0·11, Mn 0·26. It is pointed out that slow cooling and excess of sulphur produce opposite effects on the structure of the iron, the presence of sulphur tending to produce a conchoidal rather than a crystalline fracture, and the formation of such large crystals excessively rich in sulphur could only take place at an almost stationary temperature. In a postscript **H. M. Howe** suggests that the first crystals described above are probably not real crystals of iron, but masses of iron intersected by plates of graphite and cleaving along the graphite much as granite tends to cleave along the planes of the constituent mica. T. M. L.

1092. *Micrography of Nickel Steel.* **L. Guillet.** (Comptes Rendus, 136. pp. 227–229, Jan. 26, 1903.)—The addition of nickel causes a lowering of the temperature at which martensite is transformed into ferrite. Thus whilst nickel steel ($C = 0{\cdot}120$ per cent.) containing up to 7 per cent. Ni resembles ordinary steel, and consists entirely of ferrite and pearlite, at 10 per cent. Ni, martensite begins to appear, and with 15 per cent. the mass is practically pure martensite; when the percentage of nickel is further increased, white crystals, apparently of iron, appear in increasing proportions. Steels containing 0·350 and 0·900 per cent. C exhibited similar changes, but with smaller percentages of nickel. T. M. L.

1093. *Sulphide of Iron.* **H. le Chatelier** and **M. Ziegler.** (Metallographist, 6. pp. 19–38, Jan., 1903. From the Bulletin de la Société d'Encouragement.)—When iron pyrites, FeS_2, is heated to 1,200° it leaves a residue having the composition $FeS_{1\cdot01}$, which is practically pure ferrous sulphide, and under the microscope is seen almost entirely of yellow crystals of this compound; heating to 1,500° causes a further loss of sulphur, and the product has the composition $FeS_{0\cdot48}$, but consists of a mixture of sulphides with larger dendrites of metallic iron possessing, according to the orientation, a very marked hexagonal or rectangular symmetry; the iron crystals have obviously separated first from the melt. Commercial sulphide of iron has the approximate composition $FeS_{0\cdot75}$, and contains (1) yellow grains of FeS; (2) brilliant white crystals of metallic iron; and (3) a eutectic alloy similar in appearance to pearlite. It melts at about 950° and contracts about 10 per cent. on solidifying, at the same time liberating bubbles of gas. At about 130° it undergoes a dimorphous change, accompanied by a decrease of volume as the temperature rises; this is shown in a very striking way by the conductivity, which steadily falls between 20° and 140° to 5 per cent. of its initial value and then remains constant at higher temperatures. There are also indications of a second transformation at 220°. Campbell and Arnold have stated that sulphide of iron is capable of escaping through the walls of a heated iron vessel, but it is shown that the escape takes place through the joint, and in the case of wrought iron also along the slag-fibres contained in the metal, the fused sulphide being driven out by the pressure of sulphur dioxide in the vessel. The harmful effect of sulphur in iron depends on its low melting-point, which causes it to solidify last, in the form of meshes between the crystals that have already separated on cooling the fused metal; the meshes have little tenacity in the cold and none at all when the metal is heated. The best antidote consists in the addition of manganese. Specimens of manganese were prepared containing sulphur; these exhibited crystals of manganese sulphide which had separated before the manganese, and had therefore a very low solubility and a melting-point higher than that of manganese, and therefore higher than that of iron; the addition of manganese to iron causes the sulphur to separate first as manganese sulphide in isolated crystals of high melting-point instead of separating last as a network of low melting-point; the formation of sulphide of iron cannot be entirely prevented, but under these conditions it appears in isolated drops which do not weaken the iron more than would be the case if the metal contained air-bubbles. T. M. L.

1094. *Crystal Formation.* **E. Fédoroff.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 519–534, Dec., 1901.)—This is a continuation of the author's researches into the formation of crystals. His attention has lately been drawn mainly to the study of the crystallisation of sulphates, these crystals being readily obtained from their solution and belonging at the same time mostly to lower degrees of symmetry. The theory of the structure of crystals anticipates that in negative crystals there is a special direction of strongest association; the growth of crystals therefore is likely to follow preferentially this direction. The experiments recorded in this paper fully bear out this conclusion. On the other hand there should, according to theory, be in crystals of normal form one or more such directions of strongest association, as was really demonstrated by the sulphates studied by the author. A. G.

1095. *Nature of Liquid Crystals.* **R. Schenck.** (Ann. d. Physik, 9. 5. pp. 1053–1060, Dec., 1902.)—The phenomena of liquid crystals are shown most clearly in the purest preparations of azoxyanisole and can therefore scarcely be dependent on the presence of impurities, as has been suggested by Tammann, who regards the liquid crystals as emulsions of the finely divided crystals suspended in a liquid melt containing foreign substances. The uniformity of the liquid crystals has been proved by noting the absorption of light during cooling; the turbid product is equally absorbent at all temperatures, whilst if it were an emulsion, depending on the separation of one constituent from a liquid mixture, the turbidity should increase with falling temperature. [See also Abstract No. 2300 (1900).] T. M. L.

1096. *Crystallisation Form of Acid Potassium—Lithium Sulphate.* **L. L. Ivanoff.** (Soc. Imp. Nat. Moscou, Bull. 3. pp. 361–367, 1902.)—Acid potassium-lithium sulphate crystallises in the ditetragonal bipyramidal class, some novel forms being observed by the author. At temperatures of from 17° to 45° crystals of the pyramidal type are formed, whereas between 45° and 60° crystals with essentially pinacoidal surfaces are obtained. In the case of a very rapid crystallisation, rectangular sheets are separated from the supersaturated solution. The crystals are optically monaxial, negative, and exhibit strong double refraction. No pyroelectric phenomena or etching were observed. A. G.

1097. *Crystalline Form of Lithium Sulphate.* **C. Nenadkewitch.** (Soc. Imp. Nat. Moscou, Bull., 3. pp. 335–349, 1902.)—The author has revised the crystallographic properties of $Li_2SO_4H_2O$. In Grailich's previous work the numerical data do not correspond with the work of other crystallographers, the discrepancy being due, as shown by the author, to errors in calculation; a table recording Grailich's corrected values is given by the author. The crystallisation of neutral solutions gives rise to crystals showing a different behaviour from the crystal formed in solutions of lithium sulphate containing free sulphuric acid. Whereas crystals of neutral solution constitute sheets according to the formula (001), the crystals of acid solutions are generally formed according to (100) and (110). The combinations of polyhedra are simpler, (111) and (011) not being formed in the case of the temperature of crystallisation increasing up to 50° or 60° C. The author has found a new arrangement of crystals of lithium sulphate. The right and left crystals may be arranged according to the following law: The plane of arrangement, (010); plane of separation, (001). These crystals may easily be observed by a study of their electric property and their corrosion figures. The author describes the figures of corrosion as obtained by the action of water. A. G.

1098. *Effects of Strain on the Crystalline Structure of Lead.* **J. C. W. Humfrey.** (Roy. Soc., Phil. Trans. 200. pp. 225–240, Dec. 30, 1902. Roy. Soc., Proc. 70. pp. 462–464, Aug. 22, 1902 (Abstract).)—A continuation of the work of Ewing and Rosenhain [see Abstract No. 664 (1901)]. In this case a variety of pure "chemical lead" was obtained which gave single crystals of sufficient size to furnish a test piece possessing a uniform orientation throughout the part under test, so that the problem was greatly simplified. By suitable etching, a system of geometric pits in the form of negative cube-octahedra was produced, showing readily any change of orientation. The specimens were first strained in simple tension, and slip-lines were found to occur in planes parallel to an octahedral face of the etched pits. The surface assumed slight undulations at an angle of 45° to the direction of pull, which were still visible after re-etching as slight changes of orientation. When a single crystal is severely strained, especially by compression, it is seen upon re-etching that the orientation no longer remains uniform, but that the crystal has broken up into numerous small patches of various new orientations, many of them bearing a twin relation to one another. Heating such strained crystals to temperatures up to 100° C. produces further recrystallisation up to a certain limit. The structural rearrangements require a certain short interval of time for their development. Twenty-six photographs and two figures are given illustrating the changes. S. R.

1099. *Solubility of Red and Yellow Mercuric Oxide and its Dissociation.* **K. Schick.** (Zeitschr. Phys. Chem. 42. pp. 155–178, Dec. 9, 1902. Communication from the Physikalisch-Chemisches Institut der Technischen

Hochschule, at Carlsruhe.)—The solubility of yellow mercuric oxide at 25° was found to be 0·0518gm. per litre, and of the red oxide 0·0513gm.; at 100° the values were 0·41gm. per litre for the yellow and 0·38gm. per litre for the red oxide, though longer contact with the solution would probably have given values agreeing as closely as those at 25°. After long stirring the solubility of the oxide is therefore the same in the two cases, and it was noticed that at the end of the experiment the red oxide had been partially converted into minute particles of yellow oxide, thus confirming Ostwald's conclusion that the two forms of the oxide only differ in the size of the constituent particles. The solubility of the oxide is increased by adding baryta, showing that it has a greater tendency to function as an acid than to dissociate as a base; in the alkaline solution it is perhaps present as $Ba(O.Hg.OH)_2$. The pure oxide has no action on ethyl acetate, but in the presence of sodium chloride rapid hydrolysis occurs, as sodium hydroxide and mercuric chloride (or a complex mercury salt) are formed. The colour of the yellow oxide varies with the temperature, becoming gradually red above 35° or 45°. T. M. L.

1100. *Solubility of Neutral and Acid Formates of the Alkalies.* **E. Groschuff.** (Ber. Deut. Chem. Gesell. 36. pp. 1783–1795, 1903. Communicated by the Physikalisch-Technischen Reichsanstalt.)—Solubility curves are given for the various neutral and acid formates. The potassium salt always separates in an anhydrous form, but the sodium salt separates with $2H_2O$ below 25° and with $3H_2O$ below 19°, the lithium salt separating with $1H_2O$ below 94°. The acid salt $H.CO_2K$, $H.CO_2H$, only separates below 95° and the acid sodium salt $H.CO_2Na$, $H.CO_2H$ only below 66°; above these temperatures the neutral salt separates from the acid solution. T. M. L.

1101. *Behaviour of Sodium Sulphate in Aqueous Solution.* **A. Hantzsch.** (Zeitschr. Phys. Chem. 42. pp. 202–206, Dec. 9, 1902.)—Wyrouboff has stated that when freshly-prepared solutions of Na_2SO_4, $10H_2O$ and Na_2SO_4 are precipitated with alcohol, the original salt is recovered. This result, indicating the *gradual* formation of a hydrate, could not be confirmed; the freshly-prepared solutions had the same conductivity and behaved in the same way when precipitated with alcohol. The difference observed by Wyrouboff probably depends entirely on temperature; the anhydrous salt liberates heat when dissolved, and the further liberation of heat on adding alcohol may raise the temperature above 32° and lead to the separation of the anhydrous salt; the dissolution of the hydrate, on the other hand, lowers the temperature, which is thus kept below the transition-point. T. M. L.

1102. *Aluminium Fluoride.* **E. Baud.** (Comptes Rendus, 135. pp. 1103–1106, Dec. 15, 1902.)—The addition of alcohol to a neutral solution of alumina in hydrofluoric acid causes the precipitation of a crystalline hydrate, Al_2F_6, $7H_2O$, which is readily soluble in water, and has a heat of solution at 15° of 3 cals. The water is gradually evolved when the hydrate is heated, until at 250° only $1H_2O$ remains. This monohydrate is insoluble in water, and its heat of solution in hydrofluoric acid at 15° is 51·55 cals.; the difference, 42·27 cals., between this number and that for the insoluble heptahydrate (8·88 cals.) corresponds with the fixation of $6H_2O$. The following results are also arrived at: Al_2F_6 (solid) + $7H_2O$ (liquid) = Al_2F_6, $7H_2O$ (solid) + 65·95 cals. (for the insoluble hydrate) or 64·95 cals. (soluble). The heat of formation of anhydrous aluminium fluoride from the elements is found to be 499 cals., this being the highest value for an aluminium haloid compound. T. H. P.

1103. *Composition of the Hydrates of Gases.* **de Forcrand.** (Comptes Rendus, 135. pp. 959–961, Dec. 1, 1902.)—The author employs the formula, $Q/T = 30$ (where Q is the heat of formation and T the temperature) formerly arrived at by him [see Abstract No. 1734 (1902)], to determine the probable compositions of some gaseous hydrates, the following being the results: N, 4 or $5H_2O$; CH_4, $6H_2O$; CO_2, $6H_2O$; N_2O, $6H_2O$; C_2H_6, $7H_2O$; C_2H_2, $6H_2O$; C_2H_4, $7H_2O$; PH_3, $6H_2O$; H_2S, $6H_2O$; C_2H_5F, $8H_2O$; SO_2, $8H_2O$; CH_3Cl, $7H_2O$; H_2Se, $6H_2O$; Cl_2, $7H_2O$ and Br_2, $10H_2O$. It will be seen that most of these contain $6H_2O$ for each molecule of the gas, and in general the proportion of water appears to increase as the volatility of the gas decreases. The more water there is present the more volatile is the hydrate. T. H. P.

1104. *Supposed Transition-temperature of Cadmium Sulphate,* $CdSO_4\,8/3H_2O$. **H. v. Steinwehr.** (Ann. d. Physik, 9. 5. pp. 1046–1052, Dec., 1902. Communication from the Phys. Techn. Reichsanstalt.)—The measurements of Kohnstamm and Cohen showed a slight break in the solubility-curve of cadmium sulphate at 16°, which they regarded as indicating a transition-temperature. A repetition of these measurements has given an unbroken curve, and there is little doubt that the break noted by the earlier observers was due to experimental error—a conclusion that is the more probable because the difference between the two series of observations is never greater than 0·2 per cent. T. M. L.

1105. *Oxidation of Ammonia and Amines by Catalysis.* **A. Trillat.** (Comptes Rendus, 136. pp. 53–56, Jan. 5, 1903.)—When ammonia and steam are led over a platinum spiral heated to dull redness, they form ammonium nitrate and nitrite and a small quantity of free nitrogen. Under the same conditions the aliphatic amines yield nitrite, nitrate and aldehyde. Apparently the amine is first split up by the water into ammonia and alcohol, thus: $NH_2.C_2H_5 + H_2O = C_2H_5.OH + NH_3$, after which both of these products undergo oxidation. The tertiary amines are less readily oxidisable than the primary and secondary, triethylamine being scarcely attacked at all. In several cases, especially that of ethylamine, hydrogen cyanide was formed, but the conditions of its formation could not be determined. Aniline undergoes but slight decomposition, but aromatic amines containing an alkyl radicle are readily oxidised. Dimethylaniline first yields formaldehyde, the residue then condensing with dimethylaniline to form $CH_3.NH.C_6H_4.CH_2.C_6H_4.N(CH_3)_2$. T H. P.

1106. *Velocity of Reaction of Bromine on Trimethylene.* **G. Gustavson.** (Acad. Sci. St. Pétersbourg, Bull. 13. pp. 435–456, Nov., 1900.)—Examining the action of bromine or trimethylene, the author found the process to be easily accelerated by adding numerous bodies. The reaction is readily started, not only by a small amount of either non-aqueous or aqueous solutions of some bromine and chlorine salts, but also by bromhydric acids. According to the results of the author, the reaction of bromine on trimethylene does not show any material departure from the normal behaviour, except in the case of sun-rays acting on the bodies, when the trimethylene bromide obtained is very pure. In all the other cases studied the reaction of bromine on trimethylene is accompanied by the production of by-products, such as propyl and propylene bromides, containing large amounts of bromine. The most remarkable case of departure from the normal behaviour in the above process is the reaction of bromine on trimethylene in the presence of aluminium bromide, nearly half the bromides formed consisting of propylene bromide. But even in other cases, the reaction will give considerable amounts of propylene bromide, the production of which, as well as of other by-products, not depending on the percentage of impurities, but arising from the reaction between trimethylene and bromine itself. A. G.

1107. *Displacement of Osmotic Equilibrium by Surface-Forces.* **F. Kaufler.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 935–945, July, 1902.)—Considering the vapour-equilibrium between a convex and a concave surface in the case of a non-volatile solute of molecular weight m dissolved in a volatile solvent, the author arrives at the formula—

$$\Delta C = \left(\frac{1}{\rho_1} + \frac{1}{\rho_2} + \frac{1}{\rho_3} + \frac{1}{\rho_4}\right)\frac{\sigma}{S} \cdot \frac{m}{RT}$$

where ΔC = excess of concentration of solute inside the convex surface, ρ_1, ρ_2, ρ_3, ρ_4 = principal radii of curvature of the surfaces, σ = surface tension (in g. cm.), S = density of the solution, R = gas-constant, T = temperature. The above formula is very simply proved by equating the difference in vapour pressure at the two surfaces, supposed present in two vertical tubes dipping in the solution (one of the tubes not being wet by the solution), to the gravitational pressure-difference. The method of proof is in fact an extension of the method originally employed by Kelvin. For the case of two solutions in different solvents separated by a curved interface (radii of curvature ρ_1, ρ_2) the corresponding formula is—

$$\Delta C = \left(\frac{1}{\rho_1} + \frac{1}{\rho_2}\right)\frac{m}{RT}\left(\frac{\sigma_1}{s_1} + k\frac{\sigma_2}{s_2}\right)$$

where ΔC denotes the excess of concentration caused by the surface-forces in the solution (1) lying on the concave side of the interface. Applications are made to the process of dyeing. Thus in the case of cotton-wool immersed in the solution of a dye of molecular weight 600, the author calculates that $\Delta C = 0{\cdot}012$, *i.e.*, the solution inside the cellulose-cell (regarded as a circular cylinder of external diameter 20μ and internal diameter 4μ) will contain 12 grms. more dye per litre than the bath. It is pointed out that if the process of dyeing be regarded as a distribution between two solvents, namely bath and fibre, as in Witt's theory, there will exist no constant distribution-coefficient owing to the presence of the term ΔC. Finally the author mentions the possible bearing of the above formulæ on physiological phenomena occurring within animal and vegetable cells, and on the phenomena of absorption and catalysis by finely divided substances. F. G. D.

1108. *Heterogeneous Equilibria.* **J. H. van't Hoff.** (Zeitschr. Elektrochem. 8. pp. 943–946, Dec. 25, 1902. Report read before the Deutsche Chemische Gesellschaft at Berlin, Nov. 29, 1902.)—A very condensed account is given of some of the extensive researches carried out by van't Hoff in this department of physical chemistry. The subject is treated from the standpoint of the phase-law. The following points are dealt with: Allotropic transformations of NH_4NO_3, transition-points of $Na_2SO_4\ 10H_2O$ and $CaCl_2\ 6H_2O$, conditions of formation of *Astrakanite* $Na_2SO_4\ MgSO_4\ 4H_2O$, and *Schönite* $K_2SO_4 . MgSO_4 . 6H_2O$, and finally the complete isothermal diagram of the four-component system Na—K—Cl—SO_4—H_2O, showing the conditions for the formation of *Glaserite* $K_3Na(SO_4)_2$. Stress is laid by van't Hoff on the purely formal nature of the phase-law, which cannot replace or supersede a molecular treatment of the problems of chemical equilibrium. F. G. D.

1109. *Equilibrium between Silver Chloride and Oxide and Solutions of Potassium Chloride and Hydroxide.* **A. A. Noyes** and **D. A. Kohr.** (Zeitschr. Phys. Chem. 42. pp. 336–342, Dec. 23, 1902.)—According to the law of mass-action the ratio of chloride to hydroxide in a solution saturated with silver chloride and silver oxide should be proportional to the square of the solubility-ratio of silver chloride to silver oxide. The ratio of Cl' to OH' was found in three series of experiments to be 0·01052, 0·00975, 0·01029, the ratio being to some extent dependent on the concentration. Taking the mean value, the solubility of silver chloride at 25° is calculated to be $2·16 \times 10^{-5}$ mol. per litre, whilst the measurements of Kohlrausch and Rose gave $1·50 \times 10^{-5}$, a quantity of the same order of magnitude, though the percentage difference is considerable. The solubility of silver oxide at 25° was found to be $2·16 \times 10^{-4}$, and that of silver iodate $1·89 \times 10^{-4}$ mol. per litre. T. M. L.

1110. *Physical Chemistry Applied to Toxins and Antitoxins.* **Arrhenius** and **Madsen.** (Abstract by **A. Harden,** Nature, 67. pp. 114–116, Dec. 4, 1902.)—Quantitative measurements have been made of the action on the tetanus toxin "lysin" of the antitoxin "antilysin." The behaviour is exactly analogous to that which follows on mixing a base, such as ammonia, with a feeble acid, such as boric acid, when one equivalent of acid leaves the solution alkaline owing to hydrolysis of the resulting salt, but a considerable excess of the acid is able to neutralise the properties of the base. In the case in question, one equivalent of antilysin left 36 per cent. of the original hæmolytic power of the lysin, whilst seven equivalents left only 1·8 per cent. It is not suggested that the toxin and antitoxin function as acid and base, but rather that they combine to form an inert compound which, like ammonium borate, is partially hydrolysed by water. The compound is formed slowly and at a rate that can be measured. T. M. L.

1111. *Water in some of its Relations to Air.* **F. Kohlrausch.** (Zeitschr. Phys. Chem. 42. pp. 193–201, Dec. 9, 1902.)—Experiments are described on the influence exerted by the atmosphere on the conductivity of water, and methods given for preparing pure water which will not deteriorate on contact with air, if the usual precautions are observed. A simple means of freeing the water in a flask from carbon dioxide is to place a collar of slaked lime on the outside of the neck, and to protect the lime from contact with the outer air by covering it with an inverted beaker; by this means the conductivity of a large quantity of water is reduced from $0·9 \times 10^{-6}$ to $0·5 \times 10^{-6}$ in a few days. By simple contact with platinum electrodes or by passing a current of air freed from carbon dioxide through the cell containing ordinary non-platinised electrodes a further reduction to $0·3 \times 10^{-6}$ may be effected. In order that such pure water may keep a constant conductivity, it should not be stored in the laboratory, and the stopper of the vessel should be protected from dust. The breath often causes contamination, and transference of the water from one vessel to another should take place at an open window. The water should never be blown from a wash-bottle. T. H. P.

1112. *Conductivity of Potassium Chloride in Mixtures of Water and Alcohol.* **W. A. Roth.** (Zeitschr. Phys. Chem. 42. pp. 209–224, Dec. 9, 1902.)—

Measurements have been made of the conductivity of solutions of potassium chloride in mixtures of alcohol and water containing 8·00 and 20·80 per cent. alcohol by weight. The molecular conductivity is reduced by the presence of the alcohol, both the mobility and the degree of dissociation being diminished. The temperature-coefficients are considerably greater in the aqueous solutions and slowly increase with increasing dilution. The dissociation-formulæ proposed by Ostwald, by Rudolfi, and by van't Hoff do not give satisfactory constants for the aqueous-alcoholic solutions. T. M. L.

1113. *Potential-Difference between an Electrode Consisting of Two Metals and an Electrolyte which contains Salts of these Metals, treated from the Standpoint of the Phase-law.* **W. Reinders.** (Zeitschr. Phys. Chem. 42. pp. 225–240, Dec. 9, 1902.)—A theoretical account giving a complete survey of all the cases which may occur, and illustrating the theory by references to the experiments of Herschkowitsch, Ogg, Haber, Reinders, and others. The following chief cases are considered :—I. *The two metals form no compounds and no solid or liquid solutions.* The solutions which are in equilibrium with the composite electrode must contain the kations in concentrations proportional to the solution-tensions of the metals (provided the metals are equivalent). II. *The metals form a homogeneous liquid, or solid solution.* In this case we must have—

$$\sqrt[n_1]{\frac{P_1}{p_1}}=\sqrt[n_2]{\frac{P_2}{p_2}}\,,$$

when P_1 and P_2 are the *partial* solution-pressures, and p_1 and p_2 the kationic concentrations; if $n_1=n_2$, then as before $P_1/P_2=p_1/p_2$. The author modifies this formula for the case of a dilute metallic solution, and discusses by means of diagrams the various cases caused by limited miscibility (solubility) of the metals. III. *The metals form a compound.* In this case we have the interesting result that the P.D. attains a minimum value when the ratio of the kationic concentrations in the electrolyte is equal to the ratio of the metals in the compound. Such a case is quite analogous to the *true* melting-point of a binary dissociating compound, *e.g.*, a hydrated salt, or to the stable solution of a double salt. Various cases are considered, particularly those where the metals form two series of solutions as well as a compound. The above considerations lead naturally to a discussion of the electrolytic separation of metals and electrolytic analysis. A difficulty occurs here in the formation of protective coatings, which thus prevent the attainment of the theoretically possible equilibrium. The paper concludes with a discussion of the constant galvanic cells from the phase-law standpoint. The views expressed by Nernst and Bancroft on this subject are criticised unfavourably. F. G. D.

1114. *Decrease of Kathodic Depolarisation caused by Potassium Chromate.* **E. Müller.** (Zeitschr. Elektrochem. 8. pp. 909–914, Dec. 11, 1902. From the Elektrochem. Laboratorium der königl. Sächs. Technischen Hochschule at Dresden.)—Tables of figures and a current-potential curve are given which show that when a solution of potassium iodate containing potassium chromate is subjected to increasing voltage, reduction of the iodate at the kathode sets in at a kathodic potential of $-0{\cdot}2$ volt. When, however, the latter reaches $+0{\cdot}2$ volt. the current rapidly falls off and reduction of the iodate ceases, free hydrogen being now evolved. It is, therefore, clear that a certain definite kathodic current-density is necessary in order, by reduction of the chromate, to produce the protective diaphragm of chromium hydrate which annuls the kathodic depolarisation. The curve also shows that the diaphragm once formed lasts a considerable length of time so that reduction of the iodate does not at once set in when the voltage and current-density are brought back to their previous small values. Not only can the reduction of iodate to iodide be prevented by the presence of chromate, but also the reduction of the periodate which is formed at the anode during the electrolysis of the iodate solutions. Similarly reduction of pure periodate solutions can be completely prevented. At higher temperatures (75° C.) matters are very different. On electrolysing solutions of iodate at this temperature, it is found that at first there is no kathode reduction, the formation of periodate also proceeding freely. After some time, however, the periodate disappears and the solution is found to contain large quantities of iodide, thus indicating the existence of a powerful kathodic reduction. The author explains this as due to the destruction (by oxidation) of the diaphragm, caused by the periodate. All the above remarks apply to alkaline solutions. In acid solutions different phenomena occur; for example, free iodine is set free at the kathode. The reduction of free iodic acid cannot be prevented by chromate. The fact that pure chromate solutions cannot be reduced to chromium oxide is also to be explained by the initial formation of a diaphragm. In the case, however, of Street's patent, where this object is achieved by the use of a mercury kathode, it is probable that the diaphragm cannot be formed owing to the mobility of the kathode-surface. The author finally describes a pretty lecture-experiment to illustrate the elimination of kathodic depolarisation by means of chromate. [See also Abstract No. 914 (1901).] F. G. D.

1115. *Dissociation of Electrolytes.* **C. Liebenow.** (Zeitschr. Elektrochem. 8. pp. 933–938, Dec. 25, 1902.)—By considering the action of the free ions in aiding dissociation of the molecules, as well as the tendency of the molecule itself to occasionally separate into its constituent ions, the author arrives at the following dissociation-formula for a binary electrolyte—

$$\frac{\alpha^2}{(1-\alpha)v} = A + B\left(\frac{\alpha}{v}\right)^{\frac{3}{2}}$$

where α and v have their usual meanings and A and B are constants. The term $B\left(\frac{\alpha}{v}\right)^{\frac{3}{2}}$ represents the effect of the free ions in aiding the dissociation. Putting $\alpha = \frac{\lambda}{\lambda_\infty}$, the author shows that the above formula can be made with very considerable accuracy to fit the data for the conductivity of solutions of KCl over a concentration-range 0·0001 — 3. The deviations do not exceed 1 per cent. The author finally compares his formula and calculation with those given by Goebel [see Abstract 753 (1903)] and suggests that in the extended theory of electrolytic dissociation recently put forward by Nernst, account should be taken of the electrostatic influence of the free ions in promoting dissociation. F. G. D.

1116. *Gladstone-Tribe Couple.* **W. D. Bancroft.** (Amer. Electrochem. Soc., Trans. 1. pp. 66–67; Discussion, pp. 67–68, 1902.)—The author has succeeded in reproducing some of the results obtained with the zinc-copper couple by means of a pair of zinc or copper plates and an external source of current. Chloroform was decomposed with zinc electrodes in an alcoholic solution at 60° C. The resistance, large at first, rapidly diminishes as ZnCl is formed. $KClO_3$ is readily reduced to KCl with copper electrodes at 93° C. The author expects this to lead to the effecting of electrolytic reductions of both inorganic and organic compounds with much higher efficiency than is obtainable by purely chemical means. *In the discussion,* **C. P. Townsend** observed that C. Luckow had proposed a similar method for the commercial production of copper oxide. Copper electrodes are suspended in a chlorate solution, into which air is injected. No reduction of the chlorate occurs. G. W. DE T.

1117. *The Nascent State.* **C. J. Reed.** (Amer. Electrochem. Soc., Trans. 1. pp. 69–78; Discussion, pp. 79–86, 1902.)—The author maintains that the effects commonly attributed to hydrogen, oxygen, and other substances being in a nascent state, are really due, not to the nascent condition of the substance, but to the same cause which sets free the substance in question. An instance of the experimental evidence put forward by the author in favour of this view is as follows: Strips of zinc and copper in contact at one extremity are immersed in dilute HCl containing a lead salt in solution, hydrogen will be electrolytically liberated, and metallic lead will be deposited on the copper, which forms the kathode of an electrogenic cell. If the deposition of lead is increased by increasing the proportion of lead salt in the solution, the liberation of hydrogen will diminish, and the author observes that it was undoubtedly this apparent substitution of reduced metal for the reduced or nascent hydrogen which led to the assumption that the nascent hydrogen causes the reduction of the metal. If, however, a mass of finely divided tin is substituted for the zinc, the hydrogen evolution proceeds as before, but there is no reduction of the lead. If this were due to the nascent condition of the hydrogen, it should be produced in both cases. The author concludes therefore that the reduction of the lead in the former case is due to the higher e.m.f. of the zinc-copper couple, which is maintained by the energy of the dissolving zinc, and is much greater than that obtainable from tin. *In the discussion,* **C. A. Doremus** observed that there are many chemical reactions which do not involve, apparently, any electrolytic conditions, which are not capable of being effected by gaseous hydrogen, unless the hydrogen be influenced by heat or be evolved in intimate contact with the substance to be acted on. Take, for example, Marsh's test for arsenic. He considers that we are only now beginning to understand the complication of apparently simple chemical reactions. For example, in obtaining the liberation of oxygen by heating a mixture of MnO_2 and $KClO_3$ it was formerly believed that no change took place in the MnO_2, whereas it was now known that there are several chemical transformations occurring simultaneously. It might be assumed that if the molecules of elementary substances, such as H or N or O, are complex (the molecules of compounds that are also complex in the process of breaking down), either the atoms or the radicals react under conditions which, for want of a better term or better explanation, might be properly described as that of the *status nascendi.* The authors considered that the fact of ordinary gaseous H being unable to effect the Marsh test reaction showed conclusively that the reductions are due, not to the hydrogen, but to the reducing agent which simultaneously reduces the hydrogen.

G. W. DE T.

1118. *Electrical Reduction of Lead.* **P. G. Salom.** (Amer. Electrochem. Soc., Trans. 1. pp. 87–89; Discussion, pp. 89–93, 1902.)—In this paper the author describes phenomena occurring in the commercial production of lead sponge from lead ore in the process employed in the works of the Electrical Lead Reduction Company, at Niagara Falls. It had hitherto been almost universally believed that when a reducing action takes place at the kathode of an electrolytic couple, this action is due to the nascent electropositive substance produced by electrolysis. The phenomena referred to had led him to question the truth of this, but he believed that Reed's explanation of such actions [see preceding Abstract] made the matter quite clear.

G. W. DE T.

1119. *Existence of Electrolytic Peroxides of Lead, Nickel, and Bismuth.* **A. Hollard.** (Comptes Rendus, 136. pp. 229–231, Jan. 26, 1903.)—When lead is removed from solution as peroxide by electrolysis, and the weight of peroxide is determined, the ratio of lead to lead peroxide only reaches 0·861 in concentrated solution, the theory for $Pb : PbO_2$ being 0·866; in dilute solution this ratio falls steadily to 0·740, and the excessive weight of peroxide is regarded as proof that an oxide higher than PbO_2 is produced. Similar experiments are quoted as indicating the existence of higher peroxides of nickel and bismuth, possibly NiO_4 and Bi_2O_7. T. M. L.

1120. *Reduction of Insoluble Kathodes.* **A. T. Weightman.** (Journ. Phys. Chem. 7. pp. 18–28, Jan., 1903.)—The author has studied the reduction of lead sulphide to lead, when used as kathode. The efficiency of reduction is almost unaffected by the current density. By analysing the gases evolved at the kathode, the amount of reduction could be ascertained by the amount of sulphuretted hydrogen present. It was found that the efficiency could be maintained at as much as 80 per cent. under proper conditions, even when there was only 25 per cent. of sulphide present. The reduction is, however, apparently not complete, about 5 per cent. remaining unreduced. Silver sulphide shows a somewhat similar behaviour to lead sulphide, but copper sulphide differs, the amount of sulphuretted hydrogen diminishing steadily with time, and hydrogen predominating. In the case of nickel sulphide the evolution of sulphuretted hydrogen is almost zero for some time, then rises to a maximum and rapidly falls again. A sulphide having a high heat of formation, *e.g.*, ferrous sulphide, is not reduced at all. A. F.

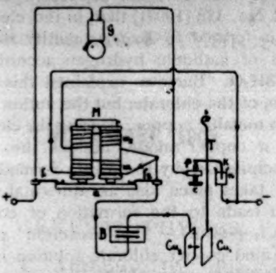
1121. *Electrolytic Preparation of Sodium Amalgam.* **E. S. Shepherd.** (Journ. Phys. Chem. 7. pp. 29–30, Jan., 1903.)—The ordinary electrolytic methods for making sodium amalgams give a dilute amalgam and require a high voltage. Since the chief reason why a solid amalgam is hard to obtain is that it has a lower density than mercury and rises to the surface and thus separates the mercury from the electrolyte, the author places the mercury in a porous pot, the bottom of which dips into the electrolyte. By this means the mercury remains in contact with electrolyte. The following table gives the author's results; the absolute current was 1–4 amperes :—

No.	Temp.	Volts.	$N.D._{100}$	Per cent. Na.	Efficiency.
1	30°	5–8	10·5	0·5	28 p.c.
2	35°	6–8	18·3	1·5	37 „
3	90°	5–7	19·0	1·3	29 „
4	90°	—	4·0	0·3	65 „
5	95°	6	7·8	1·6	60 „

A. F.

1122. *Electrolysis of Formic Acid, Oxalic Acid, and Potassium Carbonate* **F. Salzer.** (Zeitschr. Elektrochem. 8. pp. 893–903, Dec. 4, 1902. From the Laboratorium der Königl. Sächs. Technischen Hochschule at Dresden.)—The author has taken up the investigation of the reactions occurring at the anode in electrolytic oxidation, studying especially the oxidation of formic acid and oxalic acid, both with smooth and with platinised electrodes. I. *Electrolysis of Formic Acid.*—In order that the electrolyte should alter as little as possible with the removal of the formic acid, the experiments were carried out in comparatively strong solutions, either of sulphuric acid or of alkali. In the case of acid solutions with platinised anode, the potential at first rises rapidly, then more slowly, and the carbon dioxide evolved at the anode appears to have no influence on the potential at the anode. It was also found that free oxygen was evolved, causing a rise of potential, which is, however, without influence on the oxidation. A different behaviour is found with a smooth anode. After fifteen minutes the potential is 0·73 volt higher than with a platinised anode, after twenty minutes it reaches its maximum, viz., 2·66 volts, and maintains this for some time; it then falls regularly to 2·4 volts. After eight hours, the potential difference between the smooth and platinised anode is only 0·07 volt. As the potential falls, the oxidation increases from 40 to 67 per cent. of the current work. In the electrolysis of alkali solutions of sodium formate, the relationships are much simpler. The rise in potential, and the difference of potential with smooth and platinised anode correspond with those observed by Foerster and Müller in the electrolysis of NaOH [see Abstract No. 526 (1903)]. The course of the oxidation is much the same with the two kinds of anode. II. *Electrolysis of Oxalic Acid.*—In the electrolysis of oxalic acid in presence of sulphuric acid with smooth anode, the potential after about half an hour jumps up about 0·85 volt, and only a small percentage of the oxygen evolved was used in oxidising the oxalic acid. In the case of a platinised anode, the oxidation was 100 per cent. so long as the concentration of the solution with respect to oxalic acid was greater than 0·4 normal. Thereafter the potential increased, and the oxidation effect diminished. In the electrolysis of alkaline solutions of potassium oxalate (1/4-normal oxalic acid and *n*-KOH, the oxidation with smooth anode was 20–25 per cent., while with platinised anode it was 45–50 per cent., and the same relation between the potential with smooth and platinised anode was observed as in the case of the electrolysis of KOH or of sodium formate. III. *Electrolysis of Potassium Carbonate.*—The difference of potential on employing smooth and platinised anode is, after 5½ hours, 0·35 volt. The oxidation with smooth anode is 27 per cent., with freshly platinised anode about 10 per cent.; the formation of percarbonate even with platinised anode is interesting, because persulphate is not formed in a similar case. By using gauze instead of foil as anode, the formation of percarbonate is increased. When a solution of potassium bicarbonate is electrolysed, very little percarbonate is formed at the commencement, but owing to the escape of carbon dioxide, the solution becomes less acid, and the production of percarbonate increases. Therefore, the formation of percarbonate takes place most readily in neutral solution, and is diminished by OH-ions, by the presence of bicarbonate, and by platinising the anode. A. F.

1123. *A New Voltametric Balance.* **H. Paweck** and **W. Burstyn.** (Elektrochem. Zeitschr. 9. pp. 183–184, Dec., 1902.)—The authors describe a balance which they have devised for use in electro-plating work, to ensure the deposition of a known weight of metal on an object. The arrangement will be understood from the accompanying Figure. *S* is one of the knife edges of the balance from which hangs the negative electrode Cu_1 of a copper voltameter. *K* is a nickel wire dipping into mercury contained in the cup *n*. *M* is an electromagnet, round which pass the two wires w_1 and w_2 ; the keeper *a*, when attracted, makes contact with f_1 and f_2. When in operation, the current passes from the + pole of the battery to f_1, through the keeper *a* to f_2, where it divides; a portion of the current goes through w_1, whereby the electromagnet is brought into action and *a* thereby kept in place, and another



portion passes to the electro-plating bath B and thence through the voltameter and the rod K to the — pole of the battery. When an amount of copper has been deposited on Cu_1 corresponding to the weights placed on the scale pan of the balance, the plate sinks, whereby contact is made at *p*. Thereupon current passes through the wire w_2 in the reverse direction to that through w_1 ; the action of the magnet is thereby stopped, the keeper falls and breaks the circuit at $f_1 f_2$. At the same time a current passing through an independent circuit causes the warning bell *g* to sound. A. F.

1124. *Electrolytic Cells.* **C. J. Reed.** (Electrochem. Ind., Philadelphia, 1. pp. 127–130, Dec., 1902.)—This article discusses the nature of the fundamental principles underlying the action of electrolytic cells, and of the relationship between them and galvanic cells, primary and secondary. The author starts from a definition of electrochemical action as being a change of chemical valency, going on in opposite directions, at two electrodes separated by an electrolyte (which itself undergoes no change of valency). This he states to be the distinguishing characteristic of all electrolytic or electrochemical action and the only one available for defining electrolysis. The essential difference of thermochemical action is that here the opposite changes of valency occur in atoms or atomic groups which are in immediate molecular contact. The difference between the various kinds of electrolytic cells is entirely one of energy, according as they generate or absorb or else merely transmit it. E J. W.

1125. *Electrolytic Preparation of Iodoform from Acetone.* **H. Abbott.** (Journ. Phys. Chem. 7. pp. 84–91, Feb., 1903.)—The author has carefully studied the effect of temperature, current density, amount of sodium carbonate and potassium iodide, the concentration of the anode solution and the gradual addition of definite amounts of acetone at regular intervals during the electrolysis. As a result, the following are given as the most favourable conditions of preparation : current density, not more than 1·35 amperes per sq. d.cm., a temperature of 75° C., and an anode solution consisting of 6 gm. sodium carbonate, 10 gm. potassium iodide, 100 c.c. water, and 5·5 c.c. acetone, added at the rate of 0·5 c.c. per ten minutes during the electrolysis. The kathode was a cylinder of iron wire gauze, and the kathode liquid a 10 per cent. solution of sodium carbonate. The best yield was 46·88 per cent. of acetone taken, and 0·57 gm. per watt-hour. A. F.

1126. *Supposed Electrolytic Reduction of Potassium Chlorate.* **A. Brochet.** (Comptes Rendus, 136. pp. 155–157, Jan. 19, 1903.)—It has been shown by Burrows [see Abstract No. 173 (1903)] that, in the electrolysis of potassium chlorate, the chloride is formed in larger quantity than corresponds with a reduction by means of kathodic hydrogen according to the equation: $KClO_3 + 3H_2 = KCl + 3H_2O$. Burrows explained this excess of chloride as due to a direct reduction of the chlorate, but the author finds that it is caused by the action of ClO_3 on metallic copper. During the electrolysis of potassium chlorate solution with a copper anode, besides the regular formation of copper salts, their precipitation by the alkali formed at the kathode and their re-solution, there takes place also an abnormal reaction, of a purely chemical nature, which leads to the formation of copper chloride, thus: $Cu(ClO_3)_2 + 6\,Cu = CuCl_2 + 6CuO$. This reaction proceeds, without a current, when concentrated copper chlorate solution is boiled with copper turnings; a green precipitate forms, consisting of copper oxide together with chlorate and chloride. T. H. P.

1127. *Heat of Electrolytic Dissociation.* **A. Campetti.** (Accad. Sci. Torino, Atti, 38. 3a. pp. 30–41, 1902–1903.)—The author investigates the dependence of the work, corresponding with the dissociation of a given electrolyte in a certain solvent, on the values assumed by the dielectric constants of the solvent and of the dissolved electrolyte itself. The expression he arrives at for the energy (as heat) used up in the dissociation of one gram-molecule is: $Q = Nm^2/4{\cdot}17 \times 10^7\,(1/\epsilon K' - 1/\epsilon_1 K' + 1/\epsilon_1 K)$, where N is the number of molecules per gram-molecule, m the electric mass concentrated in each ion, K′ the dielectric constant of the space occupied by a molecule and K that of the medium in which the molecule dissociates, ϵ the distance between the electric charges possessed by the two ions in a molecule, and ϵ_1 the distance between the ions of the dissociated molecule and the molecules or ions of the medium itself. On making certain assumptions, the above formula becomes simplified to some extent. T. H. P.

REFERENCES.

1128. *Dissociation of Matter.* **G. le Bon.** (Revue Scientif. 18. pp. 577–590, Nov. 8; 614–625, Nov. 15; and pp. 647–657, Nov. 22, 1902.)—In these papers the author gives a comprehensive summary of recent researches bearing on the question of the possible dissociation of matter. G. W. DE T.

1129. *New Examination of the Objections of Leduc relative to the Proportion of Hydrogen in Air.* **A. Gautier.** (Comptes Rendus, 136. pp. 21–22, Jan. 5, 1903.)—The author disputes the reasoning which A. Leduc has drawn from the densities of the various gases as to the composition of air. [See Abstracts Nos. 751 and 872 (1903).] S. R.